



TYPES 1161, 1162 and 1163

**COHERENT DECADE
FREQUENCY
SYNTHESIZERS**

S/N 2

GENERAL RADIO COMPANY

West Concord, Massachusetts

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OPERATING INSTRUCTIONS

COHERENT DECADE FREQUENCY SYNTHESIZERS

Type 1161 Type 1162 Type 1163

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specifications

Type	1161	1162	1163				
Output Frequency:	0 to 100 kHz	0 to 1 MHz	30 Hz to 12 MHz				
Digital Frequency Selection (per step):	0.01 Hz to 10 kHz	0.1 Hz to 100 kHz	1 Hz to 1 MHz				
Smallest Directly Indicated Frequency Increments on CAD* Dial:	0.0001 Hz	0.001 Hz	0.01 Hz				
Incremental Frequency Range of CAD: (manually tuned)	−10 to +100 kHz down to −0.001 to +0.011 Hz	−0.1 to +1.1 MHz down to −0.01 to +0.11 Hz	−0.1 to +1.1 MHz down to −0.1 to +1.1 Hz				
RMS Phase-Noise Modulation re 1 Radian:**	−70 dB	−52 dB	−52 dB				
RMS Amplitude-Noise Modulation re 100% Carrier:**	−70 dB	−70 dB	−60 dB				
Reference-Frequency Source:	Internal, room-temperature, quartz-crystal oscillator with temperature coefficient typically $<2 \times 10^{-7}/^{\circ}\text{C}$ from 20 to 50°C. Frequency control on front panel provides adjustment range of ± 7 to ± 10 ppm. For better accuracy and stability the internal oscillator can be phase-locked to an external standard-frequency source supplying 0.25 to 5 V rms (into 1 k Ω at lowest levels, dropping to 50 Ω at high) at 5 MHz or any submultiple down to 100 kHz.						
RMS Fractional Frequency Deviation:†	Output Frequency	Averaging Time		Averaging Time		Averaging Time	
		1 s	10 ms	1 s	10 ms	1 s	10 ms
	10 MHz					3×10^{-11}	3×10^{-9}
	5 MHz					6×10^{-11}	6×10^{-9}
	1 MHz			3×10^{-10}	3×10^{-8}	3×10^{-10}	3×10^{-8}
	0.1 MHz	3×10^{-10}	3×10^{-8}	3×10^{-9}	3×10^{-7}	3×10^{-9}	3×10^{-7}
Spurious Signals (discrete nonharmonic):	<-80 dB		<-60 dB		<-60 dB		
Harmonic Signals (at max output):	<-40 dB		<-40 dB		<-30 dB		
Output Voltage:	Coupling Switch at ac: 0 to 2 V rms, metered at output connector. 50- Ω load or higher flat to within ± 1 dB above 50 Hz.		Output Impedance Switch at 50 Ω : 0 to 2 V rms, metered behind 50 Ω $\pm 10\%$.				
Monitoring Accuracy: ± 0.2 V	Coupling Switch at dc: 0 to 0.8 rms, not metered, into high impedance (>100 k Ω) flat to within ± 0.2 dB from 0 to 10 kHz.		Output Impedance Switch at 0: 0 to 2 V rms, metered at output connector. Flat to within ± 1.5 dB above 50 Hz, 50- Ω load.				
Operating Temperature Range:	0 to 50°C, ambient temperature						
Power Required:	100 to 125 or 200 to 250 V, 50 to 400 Hz; or 20 to 28 V dc, 1.8 A approx 55 watts						
Dimensions (width x height x depth):	Bench	19 x 5½ x 15½ in. (485 x 145 x 395 mm)					
	Rack	19 x 5¼ x 13 in. (485 x 135 x 330 mm)					
Weight:	Net	38 lb (17.5 kg)					
	Shipping	45 lb (20.5 kg)					

* The CAD (Continuously Adjustable Digit) provides a frequency indication on its dial accurate to two significant figures in the internal locked mode. In the external control mode $\pm 1\frac{1}{2}$ V, approx, into 6 k Ω from an external source provides frequency control over at least ± 5 major divisions centered on any manual digit setting (except that in highest rank position of CAD, sweep should not exceed limits of manual tuning). Approx -0.3 V produces a + frequency change equal to one step of digit unit at pushbutton selected position of the CAD. An internal calibrating mixer produces a beat frequency proportional to the frequency difference between the CAD and the digit units it replaces (10 kHz per Δf = digit step of selected position). This beat frequency covers 0 to 110 kHz, and a level of at least 0.5 V behind 3 k Ω is provided at the BEAT terminals. The panel meter can be switched to monitor the beat frequency, providing a self-contained calibration system that can be used to set the CAD frequency to at least four significant figures.

** Phase- and amplitude-modulation noise measured in a 0.5-Hz to 15-kHz band, after the detector, without predetection filtering. These measurements are commonly expressed by signal-to-noise ratios in a 30-kHz band centered on the signal, excluding a 1-Hz band in the center. The absolute values of the figures given are identical to these ratios (in dB).

† Period measurements on low beat frequencies between the synthesizer and a low-noise standard-frequency oscillator. Beat frequency filtered by 15-kHz low-pass filter ahead of counter. Synthesizer locked to external GR 1115 Standard-Frequency Oscillator. Signal from unlocked synthesizer may be poorer for 1-s averaging time unless in a perfectly stabilized ambient temperature, but figures given for 10 ms apply.

U.S. Patent Nos. 2,548,457; 3,300,731



TABLE 1-1
EQUIPMENT CONFIGURATIONS

TYPE 1163 COHERENT DECADE FREQUENCY SYNTHESIZER 30 c/s to 12 Mc/s

<i>Type</i>	<i>Catalog Number</i>	<i>Units Included</i>	<i>Calibrated Digits</i>		<i>Smallest Step (Digits Only)</i>
			<i>Decades Only</i>	<i>Decades + CAD*</i>	
1163-AR7C	1163-9527	7 DI Units + CAD	7	9	1 c/s
1163-AR6C	1163-9526	6 DI Units + CAD	6	8	10 c/s
1163-AR5C	1163-9525	5 DI Units + CAD	5	7	100 c/s
1163-AR4C	1163-9524	4 DI Units + CAD	4	6	1 kc/s
1163-AR3C	1163-9523	3 DI Units + CAD	3	5	10 kc/s
1163-AR7	1163-9507	7 DI Units	7		1 c/s
1163-AR6	1163-9506	6 DI Units	6		10 c/s
1163-AR5	1163-9505	5 DI Units	5		100 c/s
1163-AR4	1163-9504	4 DI Units	4		1 kc/s
1163-AR3	1163-9503	3 DI Units	3		10 kc/s

TYPE 1162 COHERENT DECADE FREQUENCY SYNTHESIZER 0 to 1 Mc/s

<i>Type</i>	<i>Catalog Number</i>	<i>Units Included</i>	<i>Calibrated Digits</i>		<i>Smallest Step (Digits Only)</i>
			<i>Decades Only</i>	<i>Decades + CAD*</i>	
1162-AR7C	1162-9527	7 DI Units + CAD	7	9	0.1 c/s
1162-AR6C	1162-9526	6 DI Units + CAD	6	8	1 c/s
1162-AR5C	1162-9525	5 DI Units + CAD	5	7	10 c/s
1162-AR4C	1162-9524	4 DI Units + CAD	4	6	100 c/s
1162-AR3C	1162-9523	3 DI Units + CAD	3	5	1 kc/s
1162-AR7	1162-9507	7 DI Units	7		0.1 c/s
1162-AR6	1162-9506	6 DI Units	6		1 c/s
1162-AR5	1162-9505	5 DI Units	5		10 c/s
1162-AR4	1162-9504	4 DI Units	4		100 c/s
1162-AR3	1162-9503	3 DI Units	3		1 kc/s

TYPE 1161 COHERENT DECADE FREQUENCY SYNTHESIZER 0 to 100 kc/s

<i>Type</i>	<i>Catalog Number</i>	<i>Units Included</i>	<i>Calibrated Digits</i>		<i>Smallest Step (Digits Only)</i>
			<i>Decades Only</i>	<i>Decades + CAD*</i>	
1161-AR7C	1161-9527	7 DI Units + CAD	7	9	0.01 c/s
1161-AR6C	1161-9526	6 DI Units + CAD	6	8	0.1 c/s
1161-AR5C	1161-9525	5 DI Units + CAD	5	7	1.0 c/s
1161-AR4C	1161-9524	4 DI Units + CAD	4	6	10 c/s
1161-AR3C	1161-9523	3 DI Units + CAD	3	5	100 c/s
1161-AR7	1161-9507	7 DI Units	7		0.01 c/s
1161-AR6	1161-9506	6 DI Units	6		0.1 c/s
1161-AR5	1161-9505	5 DI Units	5		1.0 c/s
1161-AR4	1161-9504	4 DI Units	4		10 c/s
1161-AR3	1161-9503	3 DI Units	3		100 c/s

*Direct reading (without calibration of CAD). If CAD is calibrated in terms the step decades, at least one more significant figure can be added.

SECTION 1

INTRODUCTION

1.1 PURPOSE.

The Types 1161-A, 1162-A, and 1163-A Coherent Decade Frequency Synthesizers are highly accurate oscillator systems with a direct decimal-digit readout. Each permits frequency selection precise in up to nine significant figures.

The frequency of the output signal is synthesized by proper combinations of a number of frequencies, each of which is derived from a single internal master frequency. Since each of the frequencies used for the synthesizer is derived (on a proportional basis) from this crystal-oscillator source, the output is always coherent in frequency with that of the source and has the same percentage accuracy as the source.

Frequencies are selected by means of a series of from three to seven stepped-digit units plus a continuously adjustable decade (an optional module in any version of any system). Figures 1-1 and 1-2 are indicative of the system variations possible. Remote programming capability is standard.

The synthesizers are essential in applications requiring stable, sine-wave signal sources capable of ultraprecise frequency adjustment through wide frequency regions. They are also convenient for less demanding uses.

The output frequency is readily applied to automatic recording of the frequency response of networks and the frequency drift of oscillators. Frequency markers can be formed with the aid of built-in calibration circuitry of enhance these functions.

1.2 DESCRIPTION.

1.2.1 PERFORMANCE CHARACTERISTICS.

Any member of the Type 1161-A Coherent Decade Frequency Synthesizer group supplies frequencies from 0 to 100 kc/s in step increments. A fully equip-

ped instrument has digit steps as small as 0.01 c/s and also includes a continuously adjustable decade that can be switched in beyond the smallest discrete step, or at any point in the digit series.

The Type 1162-A group is nearly identical, except that the maximum frequency is 1 Mc/s and the smallest discrete step is 0.1 c/s. Types 1161-A and 1162-A use a common chassis, thus one type can be transformed to the other by module changes.

The Type 1163-A group generates frequencies up to 12 Mc/s, with digit steps as small as 1 c/s. The Main Frame for the Type 1163-A, although possessed of the same dimensions and form factor as the Types 1161/1162 Main Frame, differs in some details and is not interchangeable.

The heart of each of the synthesizers is a set of up to seven locally controlled, plug-in modules called DI (for Digit-Insertion) units.

All frequencies are derived from a single, built-in, 5-Mc, room temperature, crystal oscillator. For maximum accuracy, this oscillator can be phase locked to an external frequency standard operating at 5 Mc/s or any submultiple thereof, such as the General Radio Type 1115 Standard-Frequency Oscillator. Refer to paragraph 1.6.1.

The continuously adjustable decade (CAD) develops a frequency, adjustable smoothly through a digit decade, that can be standardized by comparison with the output of the DI units.

Operation of the synthesizers is simple and straightforward. The rotary switches are set so that the desired frequency is indicated by rear-lit, in-line numerals. Fixed comma and decimal-point indicators are included in the readout.

Used to supplement the frequency determined by the digital setting, the CAD can, theoretically, be

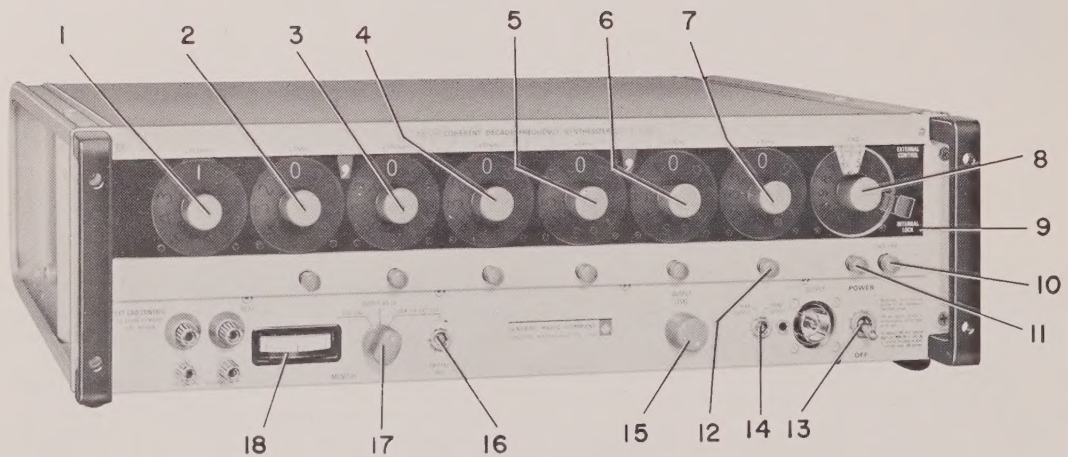


Figure 1-1. A typical Coherent Decade Frequency Synthesizer with all modules in place. Refer to Table 1-2 for callout identification.

Note: Only the basic type-number designation appears on any instrument. Model variations must be determined by reference to Table 1-1.

TABLE 1-2
CONTROLS AND INDICATORS - ALL SYSTEMS (See Figure 1-1)

<u>REF</u> <u>Fig 1-1</u>	<u>Name</u>	<u>Type</u>	<u>Function</u>	<u>Related Indicator</u>	<u>Remarks</u>
1 through 7	Digit-Insertion Dial - Stations I-VII	Rotary switch, 11-position (13-position in first station of Type 1163)	Select digits of readout	Numeral at dial top center (illuminated)	Remotely Programmable position marked "R".
8	CAD (Continuously Adjustable Decade)	Capacitor, rotary adjustment	Supplement to step digits or substitute for a group of Digit-Insertion units	Continuously calibrated dial; also MONITOR meter with switch in CAD CAL position, or signal at BEAT for any monitor-switch position.	Used only in systems with C suffixes, e.g., -AR6C.
9	CAD Mode Control - EXTERNAL CONTROL and INTERNAL LOCK	Coaxial lever switch, 2-position	Permits electronic control of CAD frequency when in EXTERNAL CONTROL position	Illuminated sector on CAD dial (dimmed in EXTERNAL CONTROL position)	
10	CAD OFF	Latching, 2-position push-button; combined rf and lamp-control switch	Places CAD on standby when actuated	Dial sector not illuminated with CAD OFF button actuated	CAD, while not contributing to output, is still warmed up and on standby.
11	CAD enable control	Latching, 2-position push-button; combined rf and lamp-control switch	Connects CAD at end of train of installed DI units	Dial sector illuminated when CAD is in use	Dial also illuminated when any of buttons (12) actuated.
12	Digit Disable Controls - Stations I-VII (II-VII in Type 1163-A)	Latching, 2-position push-buttons; combined rf and lamp-control switches	Disable Digit-Insertion units above and to the right when latched in depressed position	Digit illumination extinguished at disabled DI units.	On CAD-equipped systems, CAD substitutes for disabled units. All disabled digits are replaced by 0's, if the CAD is not installed.
13	POWER	Toggle switch, 2-position	Main ac power-input control	Dial of active DI units illuminated when power is on	
14	OUTPUT COUPLING (AC or DC coupling for Types 1161/1162) OUTPUT IMPEDANCE (0 or 50 ohms for Type 1163)	Screwdriver-actuated, 2-position switch	Change output coupling network	MONITOR meter with switch in OUTPUT VOLTS position - scale reads 0 - 2 volts, rms	No meter indication with DC coupling. Output falls off below 30 c/s in AC position.
15	OUTPUT LEVEL	Rotary potentiometer	Control level of output signal	MONITOR meter (set to OUTPUT VOLTS)	
16	CRYSTAL FREQ	Rotary potentiometer	Fine control of free-running frequency of master crystal oscillator	MONITOR meter, in LOCK TO EXT STD position, if external standard is connected	External standard (5 Mc/s or submultiple) applied to rear-apron connector (J107). Meter shows locking voltage developed in phase detector, which locks internal crystal to external standard.
17	MONITOR control	Rotary switch, 3-position	Selects function to be monitored	MONITOR meter	
18	MONITOR	Edgewise-type meter	Calibrated 0 to 2 for OUTPUT VOLTS. Also used around center scale, for CAD CAL and LOCK TO EXT STD functions.	None	In CAD CAL position, pointer homes at center scale as frequency equality is approached, then beats at low difference frequency. In LOCK TO EXT STD position, shows amplitude and sense of locking voltage.

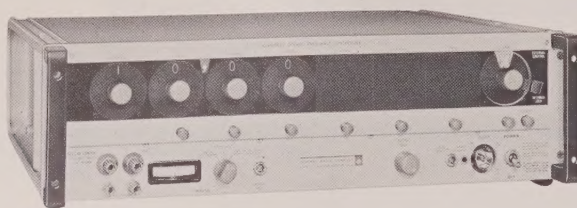


Figure 1-2. Typical -9524 synthesizer. Note the three missing Digit-Insertion units at the right and the three blank dress panels.

set to a resolution of better than 0.0001 c/s in the Type 1163-A, 0.00001 c/s in the Type 1162-A, and 0.000001 c/s in the Type 1161-A. The usable resolution is determined by oscillator stability and the time interval of interest (refer to paragraph 3.3.4).

Front-panel selection of ac or dc output coupling is provided in the Types 1161-A and 1162-A. When ac coupling is used, output voltage is indicated by the front-panel meter and is adjustable up to 2 volts into 50 ohms. Lower-level dc-coupled output, without meter indication, can be selected, when operation below 30-cycle output signal is necessary.

In the Type 1163-A dc-coupled output is not available. In units of this group, the panel meter reads output voltage either behind a 50-ohm resistor or directly at the output connector, as determined by the setting of a screwdriver-operated panel switch.

In all three types, the meter is also used:

1. to calibrate the CAD against any selected series of frequency digits set on the step-digit dials;
2. to confirm phase lock to an external standard, when such standard is connected.

The frequency of the CAD can be varied manually or by a dc-coupled external voltage for:

1. swept-frequency output;
2. narrow-band frequency modulation;
3. phase lock of the synthesizer output to external signals.

A magnified indication of the variation in synthesizer output frequency resulting from such intentional CAD variations is available at front-panel terminals, and also at the rear connector (refer to paragraphs 1.6.3 and 3.3.3).

1.2.2 MODULAR PACKAGING.

Each synthesizer, a completely self-contained frequency-generation system of modular construction, is supplied in several different configurations, as listed in Table 1-1. The variations permit the user to pre-select the frequency range and the number of significant figures required in the readout for his particular application. At any time, a less-than-complete system can be expanded by the addition of plug-in modules available from General Radio.

A minimal system consists of a standard relay-rack-width chassis, known as the Main Frame, to which are attached a Power Supply unit, an Ancillary Frequency Source, an Output Mixer, and three Digit-In-

sertion units. All units plug in and the Digit Insertion units are interchangeable. Refer to paragraph 5.4 for mechanical details. Chassis 1160-4060 serves as the Main Frame for Types 1161-A and 1162-A; Chassis 1163-4060 is used in the Type 1163-A.

Optional extra modules include additional Digit-Insertion units and the Continuously Adjustable Decade unit (CAD). When the CAD is installed, a Calibrating Mixer unit (supplied with the CAD) is also plugged in.

Either of the Main Frames has all switching, connector, and other capabilities built in, so that no rewiring or panel drilling is necessary to change digit capacity by the addition of modules. Also, Types 1161-A and 1162-A can be changed from one to the other by the change of one plug-in module.

The specific hardware difference between these systems consists in the plug-in output mixer modules and corresponding front-panel frequency-step identification strips. The Type 1161-A Output Mixer operates at 5 Mc/s, whereas in the Type 1162-A, a 50-Mc Output Multiplier-Mixer unit is used. Both modules use the same interconnections and occupy the same space at the rear of the chassis.

The Output Multiplier-Mixer of the Type 1163-A mixes a 50/51-Mc continuously adjustable input and an input selectable in 1-Mc steps, by the left-hand frequency dial, from 50 Mc/s to 39 Mc/s.

Solid-state circuits are used exclusively for compactness and performance stability.

Front-panel controls and indicators permit rapid system self-check without recourse to internal test points or adjustments (refer to paragraph 5.3).

As normally supplied, the systems are fitted out for bench-top use but can be quickly converted for rack installation with a screwdriver. Refer to paragraph 2.1 for details.

1.3 CONTROLS AND INDICATORS.

Front-panel controls and indicators common to the three synthesizer groups are listed and described in Table 1-2. See also Figure 1-1.

1.4 CONNECTORS.

Commonly used connectors for attachment of the synthesizer to other equipments are listed and described in Table 1-3. These connectors are GR874[®] quick-connect, hermaphroditic, coaxial types. In each instance, locking versions of the connector are in-

stalled. These will accept either locking or nonlocking cable connectors.

In addition, certain synthesizer frequencies, which will be useful in connection with future ancillary equipment, are available at subminiature coaxial

connectors at the rear of the Main Frame deck. They are listed in Table 1-4 (see Figures 1-1 and 2-2). The main output connector and the CAD control input and monitor are paralleled by BNC connectors at the rear.

TABLE 1-3
PRIMARY CONNECTORS

<u>Name</u>	<u>Ref Desig</u>	<u>Type</u>	<u>Function</u>	<u>Location</u>	<u>Remarks</u>
OUTPUT*	J405	GR874 coaxial	Low-loss, quick-connect terminal for output signal.	Front panel	Adaptable; refer to paragraph 1.6.7.
	J405A	BNC	Same.	Rear Bracket	
BEAT	J403	Type 938 binding posts	Terminal for external observation of CAD calibration (magnified measure of CAD frequency departure from replaced digit dials).	Front panel	Type 274-NL Patch Cord recommended accessory.
	J403A	BNC	Same.	Rear Bracket	
EXTERNAL CAD CONTROL	J401	Type 938 binding posts	Terminals for injection of external voltage to vary CAD frequency.	Front panel	0.3 Vdc equivalent to 1 major CAD dial division.
	J401A	BNC	Same.	Rear Bracket	
LOCK SIG IN	J107	GR874 coaxial, locking	Terminal for injection of 5-Mc signal (or submultiple) from external frequency standard or from another synthesizer.	Rear apron (part of AFS unit)	Type 874-R22LA Patch Cord recommended accessory.
5 MC OUT	J108	GR874 coaxial, locking	Terminal for auxiliary 5-Mc signal output.	Rear apron (part of AFS unit)	Type 874-R22LA Patch Cord recommended accessory.
100 KC OUT	J206	BNC	Terminal for auxiliary 100-kc signal output.	Rear apron (part of AFS unit)	Type 874-R22LA Patch Cord recommended accessory.

*CAUTION- Do not connect dc potential to OUTPUT without appropriate external blocking devices.

TABLE 1-4
AUXILIARY CONNECTORS

<u>Name</u>	<u>Ref Desig</u>	<u>Function</u>	<u>Remarks</u>
5/5.1	J150	Signal output to ancillary equipment; test point. Frequency in Mc/s.	Subminiature coaxial connectors at rear edge of Main Frame deck. Mate with Amphenol 'Subminiax' #27-7 or Type 5116-037475 connectors.
5.0	J151		
1.0	J152		
42	J155		
50/51	J154		
50 *	J156		
5/5.1 REF	J157		
1.0	J208		J154 and J156 present but not energized in Type 1161 synthesizers.
+18 V	J153	+18 V dc test point.	

*In Type 1163, J156 furnishes 50 to 39 Mc/s in 1-Mc steps.



1.5. ACCESSORIES SUPPLIED (Refer to Table 1-5).

TABLE 1-5
ACCESSORIES SUPPLIED

<u>Item</u>	<u>Type</u>	<u>Quantity</u>	<u>Function</u>	<u>Part Number</u>
Fuse	3AG/Slo-Blo (0.8A)	2	Spare for 115-V	5330-1200
Fuse	3AG/Slo-Blo (0.4A)	2	Spare for 215/230-V	5330-0900
Lamp	No. 327 (28V at 0.04A)	8	Spare for front-panel readout stations.	5600-1060
Bridging Unit	Plug-in	1	Spare. Completes circuits in Digit-Insertion station when active module is re- moved.	1160-4070
Cover Panel	Blank	1	Spare. Covers hole in front panel that results if a frequency-control module is removed.	1160-8015
Relay-rack mounting kit	Steel	1	Furnishes shelf support and necessary hardware to mount instrument in standard 19-inch relay rack.	7863-9632
Power cord	Rubber-molded, 1 3-wire, 7 feet long	1	Connect instrument to ac power. Rated 7A at 230 V.	4200-9622
Patch cord	Type 874-R22LA, 1 coaxial, 3 feet	1	Connect LOCK SIG IN connector to Type 1115 frequency standard, or use at OUTPUT connector.	0874-9683

1.6 ACCESSORIES AVAILABLE.

1.6.1 EXTERNAL STANDARD-FREQUENCY
OSCILLATOR — TYPE 1115

This standard meets all the requirements for a stable laboratory standard of frequency for the calibration or phase-locking control of the synthesizer output.

Its oscillator uses a 5th-overtone, 5-Mc crystal in a single-stage, proportional-control oven which maintains the crystal temperature within a few millidegrees centigrade.

A front-panel control, calibrated directly in parts in 10^{10} , allows fine control of the oscillator frequency.

The sine-wave output at 5 Mc/s, available at the rear apron, can deliver a suitable locking signal to J107 (LOCK SIG IN) at the rear of the synthesizer. A Type 874-R22LA Patch Cord is recommended for this connection. Any load from open circuit to short circuit can be connected to the output with minimal effect on the oscillator frequency.

The standard normally operates from an ac supply or, in the event of power failure or disconnection of power for up to 35 hours, from an internal, pressure-relief-type, nickel-cadmium battery supply.

1.6.2 FREQUENCY METER AND DISCRIMINATOR —
TYPE 1142-A.

This analog-type frequency meter measures frequencies from 3 c/s to 1.5 Mc/s with an over-all accuracy of $\pm 0.2\%$, and can be used with a recorder to produce time records of frequency change or drift.

The Type 1142-A frequency meter input connects to the front-panel binding posts marked BEAT on the synthesizer, via a Type 274-NL Patch Cord. It presents a highly magnified indication of the departure of the synthesizer output frequency from that displayed on the digit dials as the CAD frequency, when substituted for the step digits, is adjusted either manually or electrically. Refer to paragraph 3.3.3.

The precision six-inch meter is accurate to 1% of indication down to 10% of full scale. A calibrated

TABLE 1-6
TYPE 874 LOCKING COAXIAL ADAPTORS TO OTHER SERIES

<i>Adapts to Type</i>	<i>Type</i>	<i>Contains GR874 and ...</i>	<i>Connects GR874 to ...</i>	<i>Part Number</i>
BNC	874-QBJL	BNC Jack	BNC Plug	0874-9701
C	874-QCJL	C Jack	C Plug	0874-9703
Microdot	874-QMDJL	Microdot Jack	Microdot Plug	0874-9721
N	874-QNJL	N Jack	N Plug	0874-9711
SMA	874-QMMJL	Jack	Plug	0874-9723
SC	874-QSCJL	SC Jack	SC Plug (Sandia)	0874-9713
TNC	874-QTNJL	TNC Jack	TNC Plug	0874-9717
UHF	874-QUJL	UHF Jack	UHF Plug	0874-9719
274	874-Q2	Binding Posts	Type 274 Plug	0874-9870
APC-7	874-QAP7L	7-mm Connector	Amphenol APC-7	0874-9791

interpolation technique effectively expands the meter scale by a factor of 10, providing a readout accuracy of 0.1%.

1.6.3 SYNTHESIZER CONVERSION KITS.

Two kits are available to permit direct and rapid conversion of a Type 1161 synthesizer into a Type 1162, and vice versa. The conversion is a plug-in process that requires no rewiring or other permanent alteration. Thus, a converted synthesizer can be easily changed back to its original form. The converted instrument is complete and finished looking and indistinguishable in panel marking and every other respect from an unconverted synthesizer. Conversion in this manner from Types 1161 and 1162 to Type 1163 is not possible, however.

The kits are:

Type 1160-3040 Conversion Kit — Consists of an OMM-1 Output Multiplier-Mixer module and front-panel dial identification strip and is used to convert Type 1161 into Type 1162.

Type 1160-3030 Conversion Kit — Consists of an OM-1 Output Mixer module and front-panel dial identification strip and is used to convert Type 1162 into Type 1161.

Installation details are given in Section 5.

1.6.4 COAXIAL ADAPTORS.

As with similar General Radio equipment, the synthesizers use the quick-connect GR874 coaxial connector. However, for the user wishing to mate the instruments with components fitted with coaxial connectors of some other series, it is a simple matter to adapt to that series.

GR874 adaptors to leading commercial and military coaxial series (or to binding posts) are available to convert to the desired type. These adaptors are listed in Table 1-6.

Because the OUTPUT connector is recessed in the frontpanels an adaptor will protrude less than one inch beyond the panel. Over-all VSWR of the converted GR874 connector is typically no greater than that of the other-series connector by itself, and leakage at the GR874 junction is typically >120 dB down.

1.6.5 PRESET-FREQUENCY PROGRAM UNIT - 1160-P1.

The 1160-P1 Preset-Frequency Programming Unit (Figure 1-3) permits repetitive programming of seven-digit frequencies via a switch matrix. Up to 20 or 40 such channels can be selected, depending on model variations.

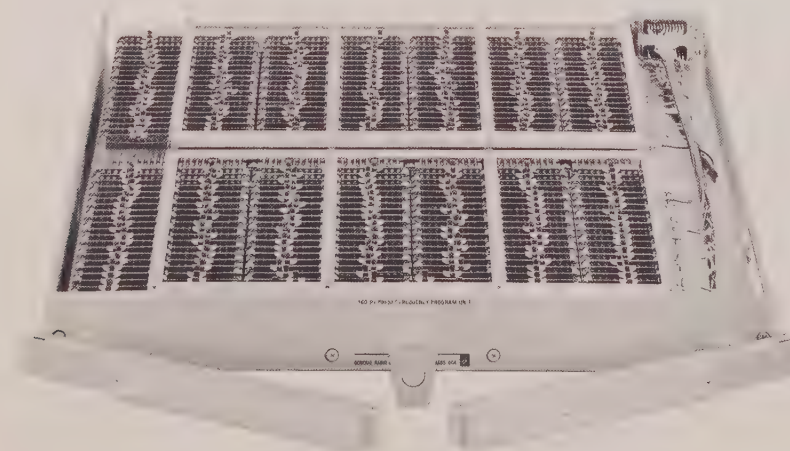


Figure 1-3. 1160-P1 Preset Frequency Programming Unit.



Figure 1-4. 1160-P2 Sweep and Marker Generator.

A programmed frequency is selected by the closure of a single contact to ground. Programmed frequencies can be stored indefinitely or can be easily reset to a new frequency, since the settings of rows of miniature switches are used to select the frequency.

1.6.6 SWEEP AND MARKET GENERATOR - 1160-P2.

The 1160-P2 Sweep and Marker Generator (Figure 1-4) takes advantage of the sweep capability of any synthesizer containing a CAD unit. The 1160-P2 sweeps the CAD frequency over a width adjustable from ± 1 to ± 5 CAD divisions (up to ± 10 divisions with CAD at center of dial). The actual sweep width can range from 1.2Mc/s to $\pm 1/10$ the frequency interval-per-step of the least significant decade, and, except for widest sweeps, can be centered on any frequency in the synthesizer's normal operating range. The oscilloscope-horizontal sweep voltage provided is independent of the frequency sweep width selected. Slow automatic and manual sweep speeds, very narrow sweep widths, and stable center frequency and markers make

the 1160-P2 particularly useful for testing high-Q devices.

The 1160-P2 generates a synthesized marker that occurs at the frequency to which the DI units are set. Side markers can be located symmetrically 1.0 to 5.9 CAD divisions from the center marker. Actual frequency spacing of these markers depends upon the functional position of the CAD unit.

1.6.7 STANDARD-FREQUENCY OSCILLATOR - 1160-P3.

The 1160-P3 Standard-Frequency Oscillator (Figure 1-5) is a stable 5-Mc/s source to which a synthesizer's internal oscillator can be locked for improved long-term stability and reduced temperature dependence. The 1160-P3 contains a temperature controlled crystal oven, buffer amplifier, and power supply and operates directly from the ac line independent of the synthesizer power switch. It mounts directly on the rear of any synthesizer model, adding only a few inches to its depth.



Figure 1-5. 1160-P3 Standard-Frequency Oscillator mounted on a typical synthesizer.

SECTION 2

INSTALLATION

2.1 MOUNTING.

The synthesizer is fitted with rubber-footed aluminum end frames for bench use. Each end frame is attached to the instrument with two panel screws and four 10-32 Phillips-head screws with notched washers.

For a rack-mounting option, special brackets and hardware are furnished to attach the instrument and its cabinet to a standard 19-inch relay rack (see Figure 2-1). These brackets permit either cabinet or instrument to be withdrawn independently.

To install the instrument in a relay rack:

a. Remove the synthesizer from its cabinet; first, remove the four knurled front-panel screws,

accessible through the clearance holes in the handles, and release the cabinet clamps at the rear.

b. Remove the end frames from the cabinet with a Phillips-head screwdriver.

c. Attach each mounting bracket (A) to the rack with two 12-24 round-head screws (B). Use the inside holes on the bracket flange; the flange must be in front of the rack rail. The shelf lip must face in.

d. Slide the empty cabinet into the brackets until the edge of the front opening is flush with the rack rail.

e. Install the knurled screws (D), supplied with the brackets, in each side of the cabinet, through the slots in the rear of the bracket.

f. Slide the instrument into the cabinet, and tighten the rear clamps, if desired.

g. Insert the four knurled screws with attached washers (C) through the panel and the bracket and thread them into the rack. The washers are provided to protect the face of the instrument.

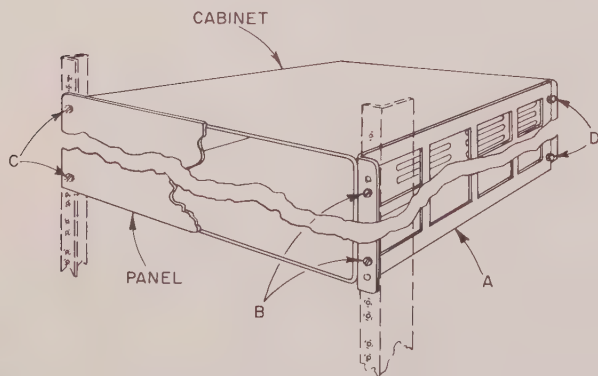


Figure 2-1. Relay-rack installation.

To remove the instrument from the rack, remove only the four panel screws (C) and slide the instrument forward out of the rack. To remove the cabinet and leave the instrument mounted in the rack, loosen only the thumb screws (D) at the rear of the brackets and pull the cabinet back off the instrument from the rear of the rack. Rear clamps, if used, must be released or tightened appropriately.



2.2 POWER CONNECTION

2.2.1 AC POWER.

Use the power cord provided to connect the synthesizer to a source of power, as indicated on the plate near the input socket at the rear of the instrument. The long cylindrical pin (ground) makes direct contact to the metal frame of the instrument.

Selection of the correct line-voltage range is made via the slide switch on the Power Supply by moving the switch until the correct range is visible. The line frequency of ac inputs should not exceed the range 50 to 400 c/s.

2.2.2 DC POWER.

The instrument can be operated from a battery supply of 20 to 28 volts, at 1.8 amperes. To so operate, remove the normal ac input-power cord and connect the positive side of the battery to a plug, part no. 4270-0900, or a metal pin 0.050 inch in diameter for insertion in J551 in the rear panel of the Power Supply module. The negative side of the battery must be connected directly to the instrument frame. If a power ON-OFF switch is desired, it must be inserted in the external wiring — the panel switch is not in circuit.

NOTE

The external dc supply should be of low impedance, such as is provided by a battery; otherwise, the internal regulator circuits may not start. If a poorly regulated dc supply must be used, the regulator can usually be started by momentary connection of J552 to the positive side of the supply, after it has come up to rated voltage.

2.3 ENVIRONMENTAL CONSIDERATIONS.

2.3.1 TEMPERATURE.

The synthesizer will operate within specifications in ambient temperatures ranging from 0 to 50°C.

2.3.2 MAGNETIC FIELDS.

Care has been taken to minimize effects of internal power-line-frequency magnetic fields on the quality of the output signal. There are, however, many ferrite-tuned and ferrite-shielded tuned circuits in the instrument, and magnetic fields from other equipments mounted nearby can, if strong enough, produce phase-modulation effects which will degrade the output signal. If power-line sidebands must be minimized, care must be taken to keep equipments that generate large external fields well separated from the instruments, or suitable additional magnetic shielding must be interposed.

2.4 DISTRIBUTION OF AUXILIARY FREQUENCIES.

GR874 coaxial terminals mounted on the rear apron of the instrument permit two fixed-frequency signals of 5 Mc/s and 100 kc/s to be taken from the synthesizer. Both are frequency coherent with the output signal and are well isolated to prevent unwanted loading effects.

One application of these terminals is to use the 5-Mc signal of one synthesizer to phase-lock the internal crystal oscillator of a second synthesizer. This can be accomplished by interconnection of the 5-MC terminal of the first instrument with the LOCK SIG IN terminal of the second. A Type 874-R22LA Patch Cord is recommended for the interconnection. Refer to paragraph 3.5 for the phase-lock procedures.

2.5 SYSTEM ALTERATION.

If your synthesizer was originally purchased as a partially complete system, the missing modules for the Digit-Insertion and/or CAD stations can be added, one at a time or as a group. No special tools are required and the change can be accomplished in minutes, with no need for rewiring or metal cutting. Retain as maintenance spares the blank panel cover and the DI Bridging Unit removed from activated stations. Refer to paragraph 5.4 for mechanical details.

SECTION 3**OPERATING PROCEDURE****CAUTION**

Do not apply dc potential to the OUTPUT without appropriate blocking devices. This precaution will avoid damage to the output amplifier circuitry.

3.1 EQUIPMENT TURN-ON.

Operation of the Coherent Decade Frequency Synthesizer to generate precision-frequency sine waves is quite straightforward. All that is necessary is to apply power, set the frequency dials to the desired frequency, and adjust the signal at the OUTPUT connector with the OUTPUT LEVEL control. The output voltage is measured by the MONITOR meter when the MONITOR switch is set at OUTPUT VOLTS. The output frequency is displayed by the dials.

NOTE

The Digit Insertion Unit dials have the ten digit positions 0 to 9 plus an eleventh position marked "R". When the dial is placed in the R position at any digit location, control of that digit is transferred to switching or other circuits that may be plugged into the connector at the rear of the digit unit. Refer to the separate section of this book on the DI unit for details. At any of the numbered dial positions, however, control remains with the local dial.

3.2 EQUIPMENT WARM-UP.

Since the equipment is all solid-state except for the dial lamps, no warm-up time is required to generate output. However, in applications where the synthesizer is phase-locked to an already operating external standard, such as the 1160-P3 Standard-Frequency Oscillator, it is necessary to allow complete equipment warm-up to a steady-state condition, if the ultimate in stability is required. Very small frequency errors due to phase drifts of tuned circuits in the synthesizer can be important in some demanding applications.

For extremely precise work, a warm-up period of two hours or more is recommended. In fact, round-the-clock operation is desirable when feasible, if high precision is apt to be required on short notice. To conserve the dial light bulbs during standby periods, depress the left-most disable button and set the CAD mode switch to EXTERNAL CONTROL.

3.3 CONTINUOUSLY ADJUSTABLE DECADE CONTROL.**3.3.1 GENERAL.**

To make use of the Continuously Adjustable Decade (CAD) to control the output frequency, and to maintain a continuous or intermittent monitor of the CAD, observe the operating instructions permanently



displayed on a front-panel instruction plate, which are as follows:

Pushbuttons select functional position of CAD (continuously adjustable decade).

CAD dial replaces the digit at actuated button and all digits to the right.

To compare CAD with replaced digits use MONITOR at CAD CAL or observe frequency at BEAT (10 kc/s per major CAD division).

This condensed instruction reminds the user of the following points:

1. If any of the gray pushbuttons is depressed (and thereby automatically latched), the digit displayed on the dial directly above the actuated button and all the digits to the right are disabled, with regard to their effects on the output frequency, and replaced by the CAD unit. If the CAD OFF button is depressed, the CAD is removed from circuit but is still operative and will not be subject to warm-up drift when later reconnected.

2. The replaced digits (which are no longer illuminated by the dial lamps but are still legible) may be used as a reference for adjustment of the CAD. There are two methods of comparison between the CAD and the darkened digits, as described in paragraphs immediately following. Refer also to paragraphs 4.4 through 4.6 for a more detailed discussion of the principles involved.

The output frequency of the "replaced" group of DI units, between 5 and 5.1 Mc/s, is also available at the subminiature coaxial connector marked 5/5.1 REFERENCE on the rear edge of the chassis deck.*

3.3.2 INTERNAL CAD MONITOR.

With the MONITOR switch in the CAD CAL position, the MONITOR meter will read upscale (right from center), if the CAD is far removed in frequency from the replaced digits. As the CAD is tuned either manually or electrically (refer to paragraph 3.3.5) to approach equality with the replaced digits, the pointer will move toward center scale and, as equality is nearly achieved, the pointer will follow the beat frequency between the CAD signal and the signal from the replaced digit-unit group. If the beat frequency is low enough to be visible as a fluttering of the pointer, the CAD has been set accurately enough to replace at least three of the darkened digit dials correctly.

3.3.3 EXTERNAL CAD MONITOR.

Regardless of the position of the MONITOR switch, a signal appears at the BEAT binding posts which is directly proportional in frequency to the difference between the CAD output and that of the digit group which it has replaced. The Type 1142-A Frequency Meter is recommended for observation of sig-

nals present at these terminals when a deliberate offset is desired between the CAD and the replaced digits. As shown on the front-panel instruction plate, this frequency difference appears at the rate of 10 kc/s per major (numbered) CAD division. This means that if the CAD has been set to replace the digits displayed on the darkened dials exactly, the signal at the BEAT terminals is at zero frequency. If the CAD is changed in tuning by an amount corresponding to one major division on its dial, or if the dial directly above the actuated button is changed by one number (from 4 to 3 or from 4 to 5, for example), the signal at the BEAT terminals will change by 10 kc/s. Smaller or larger tuning changes produce correspondingly smaller or larger proportional changes in the frequency at BEAT. Similarly, a change of one number of the digit dials immediately to the right of the actuated button, or a change of one minor division of the CAD dial, will result in a 1-kc signal change at the BEAT terminals, etc. Whenever the CAD is being used with either manual or electrical control for frequency sweep or search, this signal at the BEAT terminals may be used as a magnified measure of the departure of the output frequency from that displayed on the whole series of frequency dials.†

3.3.4 ADDITIONAL PRECISION DIGITS FROM CAD.

Paragraphs 3.3.1 through 3.3.3 show how the CAD can easily be set to precise equality with up to 4 digit dials. This feature makes it possible to generate a frequency known to several more significant figures than would be possible using only the stepped digit dials and the CAD dial markings. This capability is of most use in a stripped-down instrument, such as a Type 1162-AR4C although complete instruments sometimes can usefully employ this technique.

EXAMPLE: To set an output frequency of 953,241.72 c/s from a Type 1162-AR4C Synthesizer (which has only four digit dials), proceed as follows:

- a. Set the four digit dials to 4172.
- b. Push the button under the first (left-most) digit unit and, with the MONITOR switch in the CAD CAL position, adjust the CAD dial in the neighborhood of 4.172 until visible low-frequency beats occur on the MONITOR meter. (If these beats are slower than 5 c/s, the setting is good to the full four figures.)
- c. Now push the button under the CAD unit itself and reset the four digit dials to 9532. The output frequency from the synthesizer is now 953,241.72 c/s, the first four digits being defined by the step dials and the last four by the CAD.

Frequencies set up in this way can usually be relied on through the final figure over a period of sev-

*Not installed in some early production models.

† "Coherent Decade Frequency Synthesizers," *General Radio Experimenter*, Vol 38 No 9, September 1964, pp 11 and 13.

eral minutes, provided the CAD mode switch is in the INTERNAL LOCK position, where random drifts of the CAD are minimized. The CAD stability can be estimated, in any given situation, by observation of changes in the beatnote on the MONITOR meter while controls are set for comparison with the digits as in step b above. If this beat is observed to remain below 10 c/s over a period of time, the uncertainty in the fourth figure of the CAD contribution during this period is no greater than one unit (uncertainty of 0.01 c/s in the numerical example above).

3.3.5 CAD MODE SELECTION.

The CAD can operate in either of two modes, as selected by the lever switch coaxial with its dial. In the INTERNAL LOCK position of this switch, the CAD is in a highly stable configuration; in this mode its frequency can be changed only by manual control of its knob. In the EXTERNAL CONTROL switch position, the CAD is somewhat less stable with regard to ambient-temperature effects upon it, but it can now be tuned electrically by a signal impressed on the EXTERNAL CAD CONTROL binding posts, as well as by the knob. The dial lighting of the CAD is dimmed in the EXTERNAL CONTROL position of the switch.

When the CAD is switched for external control, a signal of 0.3 Vdc applied to the EXTERNAL CAD CONTROL binding posts will change the CAD frequency by an amount approximately equal to one major division of its dial, from a starting point as indicated by its dial setting. Positive control voltage decreases the CAD frequency, and vice versa. This relationship is recorded on the panel, adjacent to the EXTERNAL CAD CONTROL binding posts, for easy reference. The CAD can be controlled electrically up to ± 5 divisions (or more) about any center frequency at which its dial is set.

3.4 OUTPUT ADJUSTMENTS.

The remaining panel controls for routine operation consist of the OUTPUT LEVEL control and the OUTPUT COUPLING* screwdriver-operated switch, which changes the normal ac-coupled output-amplifier circuits to direct coupling. Dc coupling is used only when very low output frequencies are required. In the AC position of the OUTPUT COUPLING switch, the MONITOR switch in its OUTPUT VOLTS position connects the meter to read from 0 to 2 V rms at the output connector. In the DC position the monitor meter is no longer connected, but 0.8 volt rms is available at the OUTPUT connector at frequencies as low as desired, down to dc. The OUTPUT LEVEL control still functions, but the source impedance is generally high and is variable with setting, up to about 4 kilohms.

3.5 OPERATION WITH EXTERNAL STANDARD.

The fully clockwise position of the MONITOR switch, marked LOCK TO EXT STD, is of use only

*In the Type 1163 this control is marked OUTPUT IMPEDANCE, and determines whether a 50-ohm resistor is or is not connected in series with the output. The meter reads voltage delivered from a 5-ohm (approximate) source impedance at the input side of this 50-ohm resistor. In the ZERO position of the control the meter is directly across the output.

in applications where the stability of the internal crystal standard is not adequate and a signal from a more stable standard, such as the General Radio Type 1160-P3 Standard-Frequency Oscillator, has been connected to the LOCK SIG IN connector at the rear of the instrument. If such a signal (0.2 V rms or more, at 5 Mc/s or at a submultiple of 5 Mc/s down to 100 kc/s) has been supplied, and if the MONITOR switch is in the LOCK TO EXT STD position, the meter indicates the error voltage generated in a phase detector which disciplines the internal crystal oscillator to conform in frequency with the external standard. To check for proper operation of this phase lock, rotate the screw-driver control marked CRYSTAL FREQ and confirm that the meter follows this control smoothly from one side of center, through center, and over to the other side. The CRYSTAL FREQ control should be left so that the meter is centered, although phase lock will still obtain at any other meter indication that is still under control of the screw-driver adjustment.

3.6 CRYSTAL-OSCILLATOR ADJUSTMENT.

The CRYSTAL FREQ control can also be used as a vernier control on the frequency of the internal master oscillator, if an external locking signal is not connected. In such a case, some reference (such as a counter or other frequency meter, or a Lissajous pattern obtained with a known stable frequency on an oscilloscope) may be used. A signal sample can be taken from either of the two GR874 connectors at the rear of the instrument, on the AFS unit, marked 100 KC OUT or 5 MC OUT, or from the main output receptacle on the front panel, at whatever frequency has been dialed.

3.7 CAD DIAL INTERPRETATION.

The CAD dial displays its setting in a fashion designed to eliminate any chance for misreading. Like all the other frequency controls, the CAD knob increases output frequency with clockwise rotation. The dial carries a series of numbered fiducial lines, each of which is read against the fixed, fine-scale, illuminated sector. Figure 3-1 illustrates the principle.

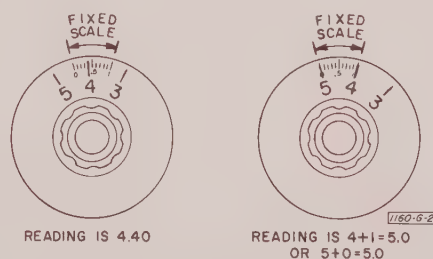


Figure 3-1. Representative readings of Continuously Adjustable Decade (CAD) dial.

3.8 SYSTEM SELF-CHECK.

Warning circuitry extinguishes the dial lamp of a malfunctioning Digit Insertion unit. In addition, the design provides for a very easy routine check for proper frequency generation. Details are covered in paragraph 5.3.



3.9 OPERATION OF SYSTEMS NOT FULLY EQUIPPED.

The design of the synthesizers permits operation with less than the full complement of digit units. The CAD can also be omitted for some applications. However, inclusion of the CAD is recommended in any but the most specialized systems. It provides very useful general-purpose features.

All the operational features discussed above (refer to paragraphs 3.1 to 3.8) apply to any of the partially equipped units, if one remembers that:

1. The CAD dial reading follows directly the last installed digit dial (when the CAD is in circuit as a result of pushing B₈, Figure 5-1).

2. All buttons under stations where digit units have not been installed act just the same as B₈—if any of them is depressed, the CAD is contributing to the output frequency and its dial reading follows immediately after the last installed dial.

3. It is important that a DI Bridging Unit (part number 1160-4070) be installed in each Digit Insertion unit station not otherwise filled. (These are installed at the factory as components of partially equipped models).

NOTE

DI Bridging Unit is supplied with each synthesizer. If for any reason one of the originally installed digit units must be removed, its place

should be filled by a digit unit taken from the right-hand end of the group of installed units and the bridging unit should be used to fill the resulting gap. (A bridging unit may be installed at any DI station except the X1MC decade of the 1163. But, unless the installed digit units are continuous, starting at the left-hand end of the chassis, the dial strip will not indicate frequency step size correctly.)

4. If the CAD unit is omitted, a CAD Bridging Unit (part number 1160-4080) should take its place. If this is done, all pushbuttons to the right of the one under the last installed digit unit are ineffective and may be depressed with no penalty.

NOTE

If the CAD Bridging Unit is not installed, it is necessary to see to it that the CAD OFF button is always depressed, otherwise the instrument will not generate proper frequencies.

5. If the CAD is omitted, none of the self-checks (paragraph 3.8) can be performed, although a partial check can still be made, without additional equipment, by setup of a 1- or 2-cycle output frequency, as noted in paragraph 5.6.5.

SECTION 4

PRINCIPLES OF OPERATION

4.1 GENERAL.

The Types 1161-A, 1162-A, and 1163-A Coherent Decade Frequency Synthesizers are so nearly identical that, except as noted, the principles of operation are the same for each. Treatment here is restricted to the system level.

4.2 DIFFERENCES BETWEEN SYSTEMS.

All three equipments are fundamentally beat-frequency oscillators. In each, a fixed frequency is subtracted (in an output mixer) from an adjustable frequency, and the resulting difference-frequency signal, suitably amplified, is the final output. (In the

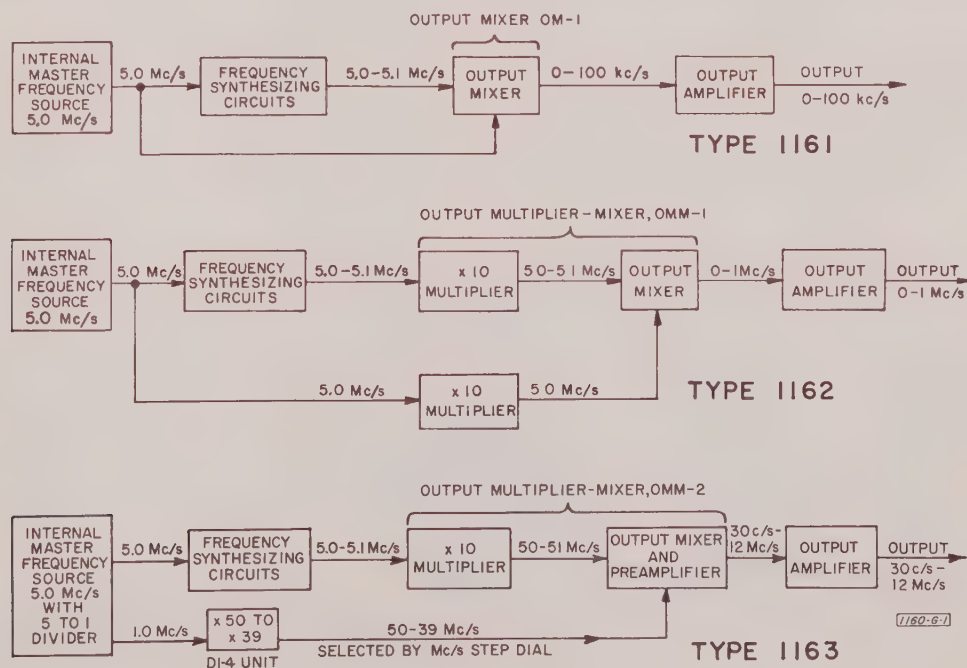


Figure 4-1. Elementary functional diagram of synthesizer circuitry.



Type 1163-A, the "fixed" frequency is itself adjustable, in 1-Mc steps, by the left-hand frequency dial).

In the Type 1161-A synthesizer, 5.0 Mc/s is subtracted from a dial-selected frequency ranging from 5.0 to 5.1 Mc/s. In the Type 1162-A synthesizer, 50.0 Mc/s is subtracted from a frequency lying between 50 and 51 Mc/s to produce the output. In the Type 1163-A, a 1-Mc signal between 50 and 39 Mc/s is subtracted from the synthesized frequency lying between 50 and 51 Mc/s. These relationships are shown in the basic block diagrams of Figure 4-1. As can be seen, the major differences between systems is in the use of the Output Mixer module, OM-1, in the Type 1161-A, use of the Output Multiplier-Mixer, OMM-1 in the Type 1162-A, and in Type 1163-A the use of a slightly different Main Frame chassis, with the megacycle-selector unit, RDI-4, and the OMM-2 Output Multiplier-Mixer installed. In the Types 1161-A and 1162-A, the Output Mixer modules are of identical physical size and can be plugged into the (1160-4060) Main Frame, thus transforming one type of instrument into the other. (A corresponding dial-strip change is also necessary.) As noted, the Type 1163-A uses a different Main Frame (1163-4060).

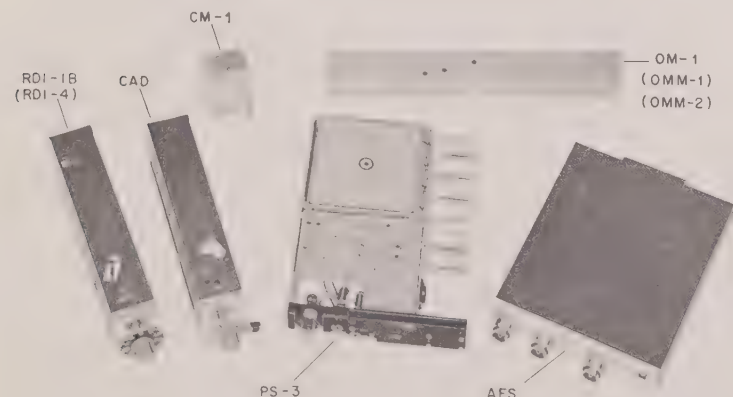
The remaining modules of either the Type 1161-A or 1162-A are as follows:

Ancillary Frequency Source
Frequency synthesizing circuits, comprising:
Digit-Insertion units
(3 to 7 may be installed)
Continuously Adjustable Decade

Calibrating Mixer
Power Supply

In the Type 1163-A the Main Frame is slightly different, and a special module – the RDI-4 – occupies the left-hand digit position.

These modules will be briefly described before the general synthesizing principle is discussed. The modules appear in Figure 4-2 and a top view of the Main Frame is shown in Figure 4-3.



LEGEND

RDI-1B Digit-Insertion Unit
RDI-4 Digit-Insertion Unit (Type 1163 only)
CAD Continuously Adjustable Decade
CM-1 Calibrating Mixer
PS-3 Power Supply
OM-1 Output Mixer (Type 1161)
OMM-1 Output Multiplier-Mixer (Type 1162)
OMM-2 Output Multiplier-Mixer (Type 1163)
AFS Ancillary Frequency Source

Figure 4-2. Typical synthesizer modules. Dial-light panels for a Digit unit and the CAD are shown on top of their respective modules.

NOTE

Detailed descriptions of each of the plug-in modules, and of each of the Main Frames, are contained in separate sections included in this book under headings appropriate to the unit in question.

4.3 MODULAR COMPONENTS.

4.3.1 GENERAL.

The DI, CAD, AFS, CM-1, and PS-3 are used in all three synthesizers and will be described first. The Output Mixer OM-1 is unique to the Type 1161-A and is replaced, in the Type 1162-A, by the OMM-1. The RDI-4 and the OMM-2 are used only in the Type 1163-A, which, as noted above, also has a slightly different chassis.

4.3.2 DIGIT-INSERTION UNIT – TYPE 1160-RDI-1B.

This module, basic to all the frequency-synthesizer assemblies in this series, is used repetitively to provide selection of each available digit. A DI unit is plugged in behind each of the digit dials.

The RDI-1B provides ten local-control digit-selection positions on its dial, plus an "R" position which transfers control to a connector at the rear of the RDI-1B unit itself.

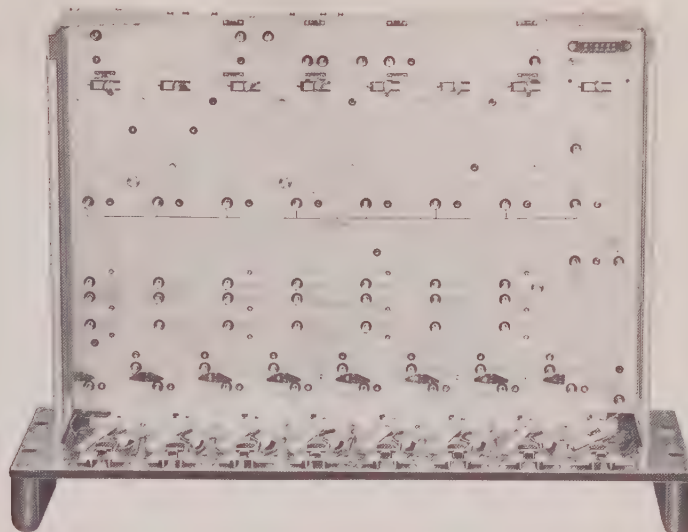
4.3.3 CONTINUOUSLY ADJUSTABLE DECADE – TYPE 1160-CAD.

This unit provides continuous frequency coverage on a single dial over wide or narrow frequency regions as selected by pushbuttons. It may be omitted if continuous coverage is not required, although it is valuable for system self-checks (refer to paragraph 3.8). It is used in all synthesizers.

4.3.4 ANCILLARY FREQUENCY SOURCE – AFS

In this module is the 5-Mc/s master crystal oscillator from which all frequencies used in the synthesis are derived. It furnishes an output at 42 Mc/s, which is fed to all the DI units and to the CAD. It also generates a "picket fence" of frequencies spaced

Figure 4-3. Top view of synthesizer Main Frame chassis used for Type 1161-A and 1162-A (refer to Section BA). The Main Frame for the Type 1163-A is nearly the same (refer to Section BB).



100 kc/s apart between 3 and 3.9 Mc/s. This picket fence is used in each DI unit for digit-selection purposes. It also supplies 1.0 Mc/s to RDI-4 unit in the Type 1163-A.

4.3.5 CALIBRATING MIXER — CM-1.

This simple module compares the output frequency of the CAD unit with the dialed output frequency of any chosen group of DI units for self-calibration or marker generation. If the CAD unit is not installed in a system, this mixer is omitted also.

4.3.6 OUTPUT MIXER, OM-1, AND OUTPUT MULTIPLIER-MIXER, OMM-1.

These modules, mechanically interchangeable, provide frequency translation between the synthesizing modules and the output circuits of the Types 1161-A and 1162-A synthesizers, respectively. Replacement of one by the other in the (1160-4060) Main Frame changes the instrument from a Type 1161-A to a Type 1162-A, or vice versa.

4.3.7 POWER SUPPLY — PS-3.

This unit accepts ac power from the line or dc from a 20- to 28-V battery and supplies 18 V, regulated, to operate the synthesizer.

4.3.8 DIGIT-INSERTION UNIT — TYPE 1163-RDI-4.

The RDI-4 unit, which supplies digit steps of 1 Mc/s, is mounted on the 1163-4060 chassis in the left-hand digit station. Its only signal input is one of 1.0 Mc/s, taken from the AFS unit. Its output is one of 12 frequencies (from 50 to 39 Mc/s) that are beat with a signal (between 50 and 51 Mc/s) synthesized by the DI units. The RDI-4 unit has the same form factor as the DI and bears a dial marked from 0 to 11 that reads 1-Mc steps in the final output frequency plus the 'R' position that transfers control to a connector at the rear of the module.

4.3.9 OUTPUT MULTIPLIER-MIXER 1163-OMM-2.

This module, which is of the same size and shape as the OM-1 and OMM-1 of the Type 1161/1162 synthesizers, plugs into the top rear of the chassis of the Type 1163-A. It combines the output frequency of the

train of DI units to produce the final output frequency of the synthesizer. It also includes a preamplifier for the output-frequency signal generated in the low-level mixer of this unit.

4.3.10 MAIN FRAME.

Figure 4-3 shows the Main Frame into which the above listed modules are plugged to make up either a Type 1161-A or a Type 1162-A synthesizer. Its deck is of "sandwich" construction, with banana plugs protruding downward to engage the power supply and the AFS, and upward to connect with all other modules. It contains the pushbutton switches that control the functional position of the CAD, the monitoring circuits, and the final-output amplifier. The Main Frame for the Type 1163-A is nearly identical.

4.4 THE SYNTHESIZING PRINCIPLE.

The discussion which follows is based on the Types 1161-A and 1162-A. The Type 1163-A utilizes all the principles described here, with some additions which are covered separately in paragraph 4.7.

The blocks in Figure 4-1 labeled "Frequency Synthesizing Circuits" comprise, in a complete instrument, a train of eight units of the same outside dimensions (seven DI units and a CAD). In the synthesizing process, the signal starts at the right-hand end of the train (at the CAD unit) and proceeds toward the left through seven* identical Digit Insertion units in sequence, being slightly modified in accordance with the dialed digit information as it passes through each unit. The frequency level, through this whole section, is always between 5.0 and 5.1 Mc/s.

Each DI module in the synthesizer receives an input signal at about 5 Mc/s, modifies the frequency of this signal very slightly in two steps, and delivers the modified frequency (again near 5 Mc/s) as an input to the next DI unit in the train. Figure 4-4 is an elementary diagram showing the essential processes performed in a DI unit.

*Six, in the Type 1163

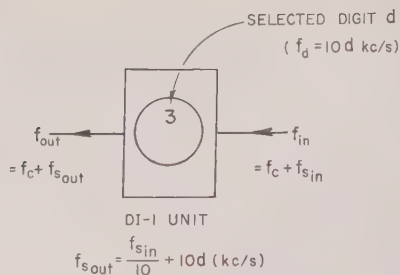


Figure 4-4. Signal traversing a typical DI Digit-Insertion unit.

In Figure 4-4 each signal (input and output) is shown as having a frequency that, for convenience, may be regarded as the sum of two components. The first component is a "carrier" frequency, which remains unchanged through all the DI units at 5000 kc/s.

The second component is the "signal" component. The signal component always lies between 0 and 100 kc/s.

The signal component is modified by passage through each Digit-Insertion unit in the following very simple ways, as indicated in the figure. If we denote the total input frequency by

$$f_{in} = f_c + f_{s_{in}} \quad \text{kc/s} \quad (4-1)$$

and the output frequency by

$$f_{out} = f_c + f_{s_{out}} \quad \text{kc/s} \quad (4-2)$$

then the DI unit performs operations so that:

$$f_{out} = f_c + \frac{f_{s_{in}}}{10} + 10d \quad \text{kc/s} \quad (4-3)$$

or

$$f_{s_{out}} = \frac{f_{s_{in}}}{10} + 10d \quad \text{kc/s} \quad (4-4)$$

where

f_{in}, f_{out} = total input and output frequencies
 f_c = carrier component, invariant

$f_{s_{in}}$ = signal component of input
 $f_{s_{out}}$ = signal component of output
 d = selected digit, from 0 to 9 in integral steps.

For convenience in following frequency changes through the train of digit units, we can disregard the carrier component, since this passes through unchanged, and concentrate on only the signal component, as in Equation (4-4).

Figure 4-5 shows four DI units (A, B, C, D), each with digits selected as indicated, and the signal-component flow through the train, from right to left. Observe the correspondence between the signal component of output frequency from unit A (24.39 kc/s) and the digit dial settings (2439). The output frequency from any unit in such a train of digit units will have a signal component that is, in kilocycles per second:

$$f_s = 10d_1 + d_2 + 0.1d_3 + 0.01d_4 + \dots \quad (4-5)$$

where d_1 represents the dialed digit on the unit at which the output frequency is measured, and d_2 through d_n represent digits dialed on successive units to the right.

Equation (4-4) defines the two fundamental operations performed on the signal component by each digit unit, which permit frequency synthesis in steps as small as may be desired. These operations are:

1. Divide the input signal component by 10.
2. Add to this a digit component that is 10 times the dialed digit (in kc/s), and pass the result on to the input of the next DI unit in the train.

4.5 CAD SWITCHING AND SELF CALIBRATION.

Behind each pushbutton on the panel is an rf switch which controls the functional position of the CAD and also arranges for the self-calibration feature. The simplified block diagrams of Figure 4-6 and 4-7 illustrate the principle; for more detailed information, see the separate sections on the Main Frames. The actual switching is a little more complex than shown in Figures 4-6 and 4-7, due to the necessity for shielding, but the signal paths are the same.

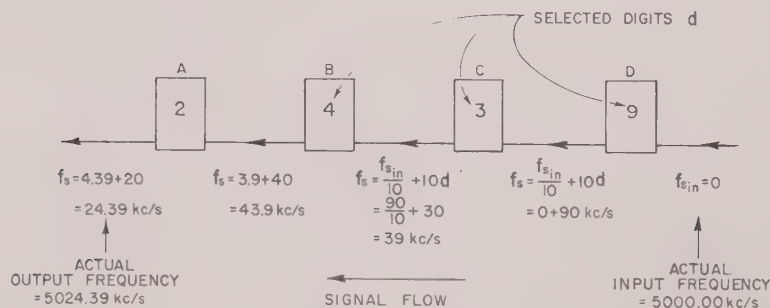


Figure 4-5. Signal flow through four Digit-Insertion units shown to illustrate synthesis of desired signal component.

Figure 4-6 shows seven DI units with dials set as indicated by the numbers in the boxes at the top. The resulting "signal components" (refer to Equation 4-4) of frequency passing between them appear below the boxes. The CAD unit, although present, is disconnected from the train because the CAD OFF button unlatches all other buttons, so that the switches are positioned as shown in Figure 4-6.

Figure 4-7 is the same except that B_5 has now been depressed, so that the CAD is operative and its output becomes the input to digit unit number 4.

With reference to Figures 4-6 and 4-7, observe that:

1. The output frequency is the same in each, though in Figure 4-6 seven digit units are working and the CAD is idle, while in Figure 4-7 four digit units and the CAD cooperate to produce the output frequency.

2. The beat-frequency output from the Calibrating Mixer is 0 in Figure 4-7, indicating that the CAD has correctly replaced digit units numbers 5, 6, and 7.

Consider now what would have been the result in Figure 4-7 if the CAD dial had been set to 6.13 instead of 5.13 as shown. First, the signal components would have been modified as indicated in the first five lines of Table 4-1.

Second, the synthesizer output frequency would have been increased by 1.00 c/s (if Type 1161-A), or by 10.0 c/s (if Type 1162-A), and third, the beat frequency available at the BEAT binding posts would have changed from 0 to 10 kc/s, as shown at the bottom of the table.

If button B_6 is pushed instead of B_5 , a change of one major division of the CAD will still produce a 10-kc/s change at BEAT, but the effect on the output frequency in the Type 1161-A is only 0.1 c/s.

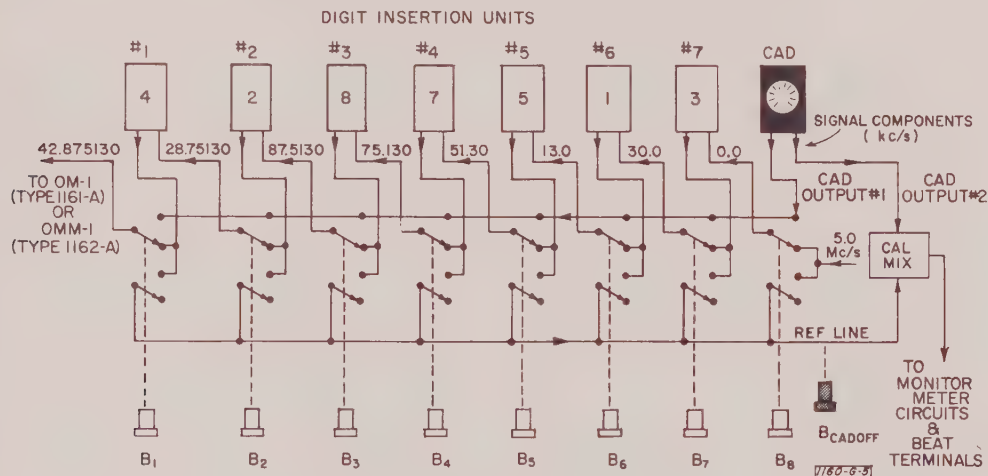


Figure 4-6. Example of synthesis achieved by seven Digit-Insertion units. Pushbutton $B_{CAD\ OFF}$ has been actuated so that CAD is not contributing to the output.

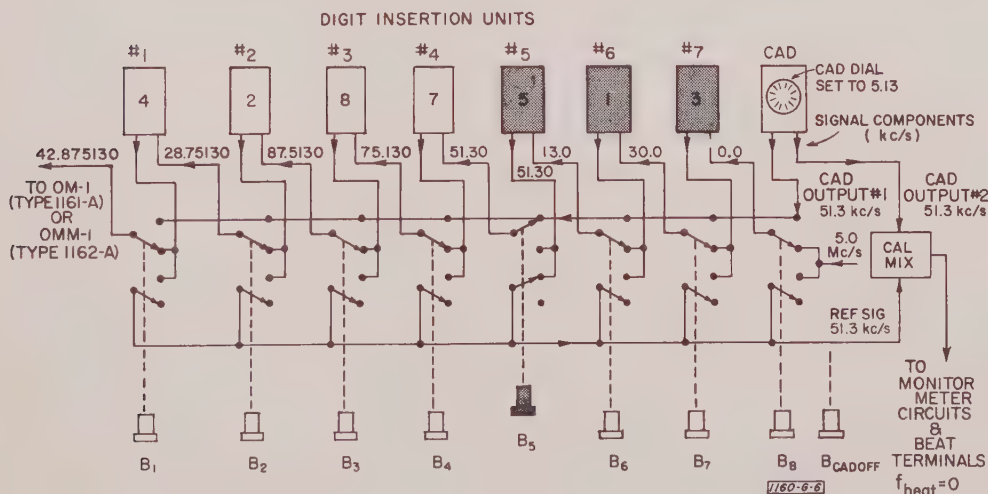


Figure 4-7. Example of synthesis by four Digit-Insertion units and the CAD. Pushbutton B_5 has been actuated so that the input to digit unit 4 comes from CAD. The output of the digit unit 5 is compared with the CAD output in the Calibrating Mixer. As shown, zero beat is achieved.



TABLE 4-1
EFFECT OF CAD ON SYNTHESIZER READOUT

Signal Components	CAD at 5.13	
	as in Figure 4-7	CAD at 6.13
Input to digit unit 4	51.3 kc/s	61.3 kc/s
Input to digit unit 3	75.13 kc/s	76.13 kc/s
Input to digit unit 2	87.513 kc/s	87.613 kc/s
Input to digit unit 1	28.7513 kc/s	28.7613 kc/s
Output of digit unit 1	42.87513 kc/s	42.87613 kc/s
Synthesizer Output (if Type 1161)	42,875.13 c/s	42,876.13 c/s (change = 1.0 c/s)
Synthesizer Output (if Type 1162)	428, 751.3 c/s	428,761.3 c/s (change = 10.0 c/s)
Output at BEAT terminals	0	10 kc/s

Or, if button B_3 is depressed, one major division change of the CAD will change the output frequency by 100 c/s in the Type 1161-A or by 1 kc/s in the Type 1162-A. In either event, the change at BEAT is still 10 kc/s.

4.6 DIAL LIGHTING.

Behind each dial is a white plastic plug-in assembly which contains a lamp bulb. In normal operation, each of these lamps is turned on whenever the corresponding digit unit (or CAD) is contributing to the output frequency.

A second set of switches, operated by the push-buttons (but not shown in Figures 4-6 and 4-7), serves to turn off all digit-dial lights above and to the right of any actuated button, and to turn on the CAD dial lamp. Figure 4-8 shows the wiring of these switches, and also the set of transistors, mounted on the lamp-switching cards behind the front panel, which sense malfunction of phase lock in a digit unit and extinguish the corresponding dial light to give warning.

Pushbuttons B_1 through B_7 operate the lamp switches of Figure 4-8 and also the rf switches of Figures 4-6 and 4-7. B_8 operates only an rf switch, and B_{CAD} OFF controls only a lamp switch, as shown. When B_{CAD} OFF is actuated, the CAD lamp is off and all other lamps are on; whenever any other button is depressed, the CAD dial is illuminated.

NOTE

Each button, when actuated, latches in the depressed position and at the same time releases all other buttons to normal position.

Figure 4-8 shows seven error-sensing probes, each of which makes contact to a pin protruding through the front panel of the Digit Insertion unit installed behind the corresponding dial lamp. Each of these pins is normally at a positive potential with respect to ground. Hence, the transistors shown in Figure 4-8 are all turned on, and each lamp circuit to ground is complete.

Lamps corresponding to button B_5 (which is depressed) and to B_6 and B_7 are extinguished by the opening of the switch at B_5 , which disconnects the voltage source from these lamps.

In the event of a phase-lock malfunction in a DI unit, however, the probe in the digit unit at fault will be at ground potential. The corresponding transistor is turned off and the lamp extinguished. (For details of the error-sensing circuits, see the separate sections of this book on the Digit-Insertion units.)

An additional switch, ganged with the EXT CONTROL-INTERNAL LOCK switch, is shown at the right of Figure 4-8. As indicated, this inserts a resistor in series with the CAD dial lamp, when the CAD mode switch is in the EXTERNAL CONTROL position, to dim the lamp.

4.7 TYPE 1163-IDENTITIES AND DIFFERENCES.

The only important difference between the Type 1163-A and its two lower-frequency counterparts is in the signals fed to its output mixer, to generate the final output-frequency band. In what follows, familiarity with the material of paragraphs 4.1-4.6 is assumed.

In the Type 1163-A, the output mixer is fed, on one side, by a synthesized frequency between 50 and 51 Mc/s, produced exactly as in the Type 1162-A, by multiplication by ten of the output frequency of a train of DI units (see Figure 4-1).

The other side of the output mixer is supplied by one of twelve frequencies, selected by the dial of the RDI-4 unit, which lie between 50 and 39 Mc/s at 1-Mc intervals. The RDI-4 unit occupies the left-hand digit-unit station on the Main Frame, in a location corresponding to the highest-rank digit unit in the Type 1161 or 1162. Since the input and output signals of the RDI-4 are different from those of a DI, the chassis wiring of the Type 1163-A is different in this region.

The RDI-4 unit takes 1.0 Mc/s as its only signal input, and, by sampling-phase-detector and locked-

oscillator techniques, develops an output at 50 Mc/s when its dial is set at 0, 49 Mc/s at a dial setting of 1, and so on, to an output of 39 Mc/s at 11 on its dial.

This output signal is fed by wiring in the sandwich deck to the output mixer in the Output Multiplier-Mixer Unit, OMM-2.

Since the CAD can never functionally replace the RDI-4, the pushbutton under this unit is not installed in the 1163-4060 chassis.

Otherwise, the operation of the pushbuttons and of the CAD is exactly as in the Types 1161-A and 1162-A, described in detail earlier. Figures 4-6, 4-7, and 4-8 are adequate for an understanding of the principles involved, if one bears in mind that the #1 digit-unit station is occupied by an RDI-4 Unit, which supplies 1-Mc spaced frequencies to the OMM-2. Pushbutton

B₁ and its associated switching are omitted, and the output to the other side of the OMM-2 is taken, via the switch associated with button B₂, from the last (sixth) DI Unit, in station #2.

The Output Multiplier-Mixer OMM-2 has the same dimensions as the OM-1 or the OMM-1 and occupies a corresponding position on the chassis. About half is occupied by circuits identical with those in the OMM-1 for multiplication of 5/5.1 to 50/51 Mc/s. The other half contains the mixer and a preamplifier that raises the output of this low-level mixer to a level suitable for input to the Output Amplifier, mounted behind the bottom of the front panel.

The Output Amplifier is very similar to that used in the 1160-4060 chassis but has greater bandwidth, on account of the 12-Mc top frequency.

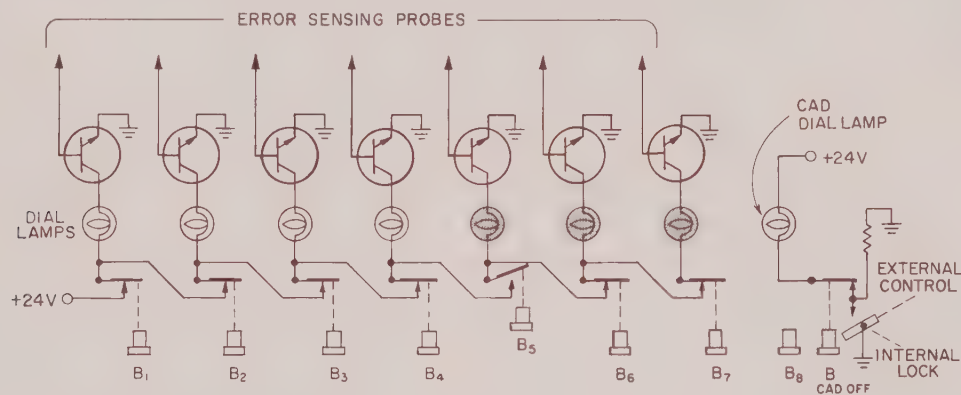


Figure 4-8. Dial-lamp switching circuits with B₅ actuated; lamps 5, 6 and 7 are off, CAD lamp is on. See also Figures 4-6 and 4-7 for rf switching, also controlled by pushbuttons B₁ through B₈. This figure (plus Figures 4-6 and 4-7) is illustrative of either a Type 1161-A or Type 1162-A synthesizer. In a Type 1163-A, pushbutton B₁ and its associated switching are omitted, and station #1 is occupied by an RDI-4 Unit. Refer to sub-sections BA and BB on the Main Frame.



SECTION 5

SERVICE AND MAINTENANCE

5.1 WARRANTY.

We warrant that each new instrument sold direct is free from defects in material and workmanship and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, District Office, or authorized repair agency personnel will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

NOTE

Each interchangeable plug-in module carries its own individual serial number, and the serial number on the front panel of the synthesizer applies only to the Main Frame.

Before returning an instrument to General Radio for service, please write to the Service Department or nearest District Office, requesting a "Returned Material Tag." Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.2 SERVICE INSTRUCTIONS.

This section is devoted to a description of the mounting arrangements for the various plug-in modules and to suggestions for methods of localizing trouble to a particular module, if any system malfunction is discovered. Refer to paragraph 5.3 for system self-check procedures. Most of the following is written in terms of the Types 1161-A/1162-A synthesizers. Applications to the Type 1163-A should be obvious, since all units are so nearly identical. For more details on the differences, refer also to Sections BA and BB, on the Main Frames, and the sections on the modules.

If improper frequency generation in a Type 1163-A is suspected, refer also to Section DC.

5.3 SYSTEM SELF-CHECK.

5.3.1 GENERAL.

The calibration circuitry permits a very easy check of each digit unit, by the methods discussed below. Refer to the digit dials by number, from D₁ to D₇, and to the pushbuttons by number, from B₁ to B₈ plus BCAD OFF, as indicated in Figure 5-1.

NOTE

Set the MONITOR switch at CAD CAL, as indicated, and the CAD mode switch in the INTERNAL LOCK position.

5.3.2 LOW-END CHECK (ZEROS).

To check the low-end ("0" digit) frequency of all installed DI Digit-Insertion units, proceed as follows:

- a. Set all digit dials to zero, and actuate B₈, under the CAD unit.

b. Adjust the CAD dial to (or close to) 0.000 to achieve a visible low-frequency oscillation of the needle of the MONITOR meter.

NOTE

By this process, the actual output frequency of the CAD has been set to 5.0 Mc/s, exactly corresponding to digit "0". (The error, at 5 Mc/s, is only the visible beat frequency, which is completely negligible in its effect on the synthesizer output frequency.)

c. Now actuate B₇. (If the instrument is a stripped-down version, with fewer than 7 DI units, actuate the button under the last installed unit.) In a complete instrument the digit dial reading is now 0000000, (the underline under the last digit indicates that the button under this digit has been depressed). If digit-unit 7 is behaving properly in its "0" position, the beat on the MONITOR meter will be unchanged from that set-up under step a. If the beat disappears, digit-unit 7 is not operating properly and should be serviced. (See detailed section of this book on the DI unit.)

d. Actuate B₆. (Digit dial reading is 0000000, with actuated button indicated by underline, as before.) Beat on MONITOR should be unchanged. If it disappears, digit-unit 6 needs service.

e. Continue to actuate buttons progressively toward the left, from reading 0000000 through 0000000 and so on to 0000000, with B₁ actuated.* If all digit units are generating "0's" properly, the beat on the MONITOR meter will be unchanged through this whole sequence. If the low-frequency beat disappears when any button is depressed, the digit unit at that station needs attention. (It may easily be removed for repair, the only penalty being the temporary loss of one digit of resolution. Refer to paragraph 5.5.1 for procedural details.)

5.3.3 HIGH-END CHECK (NINES).

To check the high end ("9" digit) proceed as follows:

a. Set D₁ to 9 (so that the reading is 9000000, with all other digit dials still at 0 and B₁ actuated).†

b. Then, adjust the CAD to (or close to) 9.000 to achieve a low-frequency beat on the MONITOR meter.

c. Depress button B₂ and set D₂ to 9 (reading is now 9900000). If both the digit units at D₁ and D₂ are behaving normally, the beat will be unchanged. (If it is not, refer to paragraph 5.3.5.)

d. Continue, in sequence, to set dials to 9 and to depress buttons, from reading 9990000 through

9999000 to 999999. If all digit units are normal, the beat on the MONITOR meter will be unchanged through this sequence. If the visible beat disappears at any step, the digit unit at that station probably needs servicing. (Refer to the section of this book on the DI unit.)

5.3.4 SEQUENTIAL CHECK OF OTHER DIGITS.

In general, a check of the end points, at 0 and 9, will give reasonable assurance that the intermediate digits are also functioning properly, but in case of doubt any digit can be confirmed. For instance, set D₁ to 4, depress button B₁, and set the CAD for a visible beat. Then, set D₂ to 4 and depress B₂, for a reading of 4400000, and continue (as in paragraphs 5.3.2 and 5.3.3) through readings of 4440000 to 4444444. (Digits 4 and 5, as well as 0 and 9, are logical candidates for this sort of check, since the internal-selection scheme in the DI requires a tracking adjustment between the lower and upper halves of the decade.)

5.3.5 RESOLUTION OF AMBIGUITY.

If step c of paragraph 5.3.3 fails to check, it is possible that the unit at D₁ may itself be in error in the "9" position. In this case the CAD, having been set erroneously to agree with D₁ (which is here assumed to be wrong) will not give a proper check against a correct D₂. On the other hand, D₁ may be right and D₂ wrong. To resolve this ambiguity, compare D₂ with D₃ (reading 9200000 compared with 9920000) or any other adjacent pair of digit units, to make sure that the CAD has been set to a true reading of 9.000. Once this has been done, the now-verified correct setting of the CAD can be used to discover an error in the unit at D₂ (reading 9200000 fails to produce a visible beat). If D₂ is found to be correct and D₁ fails, then the unit at D₁ is in need of service.

5.3.6 CHECK BY DIAL-LIGHT FAILURE.

The procedures of paragraphs 5.3.2 and 5.3.3 will always spot a malfunction at the frequency endpoints of any digit unit, and these checks are quite easy to perform. However, built-in warning circuitry will usually provide a direct and immediate indication

*In the Type 1163-A, the maximum number of DI units that can be installed is 6 and button B₁ is omitted. To check the operation of the RDI-4 unit, installed in the last station, consult Section DD.

†In the Type 1163-A, D₁ is on the RDI-4 unit, so the starting point of this series of checks is at D₂, with a dial reading of X200000. The RDI-4 setting, indicated by X, is immaterial.

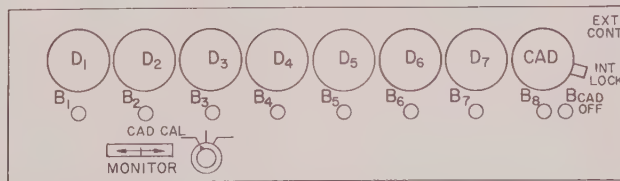


Figure 5-1.

Dial and pushbutton designators for system self-check procedures.



of such trouble, should it occur. These circuits automatically extinguish the dial lighting for a digit unit in which failure has developed. Refer to paragraph 4.6 and the detailed section of this book on the DI unit. See also the section on the RDI-4 unit used in the Type 1163-A, which has a similar provision for warning by dial light.

NOTE

This dial-light failure might, however, be caused by burn-out of the lamp itself, or by a fault in the wiring or switching in the lamp circuit. The procedures of paragraphs 5.3.2 to 5.3.5 may be followed whenever any doubt exists as to the exact cause.

5.3.7 NONSEQUENTIAL DIGIT CHECK.

It is possible to check any dial digit by comparison, through the CAD, with the corresponding digit on another Digit Insertion unit. For example, if unit 7 is known to be good and there is some doubt about unit 6, compare all digits in unit 6 with those in unit 7 as follows:

- a. Set both dials to 0, depress B₇, and adjust the CAD for a visible beat on the monitor meter.
- b. Depress B₆; the beat should be unchanged.
- c. Set both dials to 1, press B₇, and adjust the CAD for a visible beat.
- d. Return D₇ to 0 and depress B₆; beat should be unchanged.
- e. Continue through the remaining digits, remembering that each time before B₆ is depressed the reading of D₇ must be returned to 0.

By an analogous process, any digit unit can be checked against any other to its right, provided that it is known that all digit units to the right of the suspected unit are performing properly.

5.3.8 FREQUENCY CHECK NOT REQUIRING CAD

Another type of frequency check is possible, using the 5/5.1-Mc and the 5/5.1-Mc REFERENCE signal at J150 is the output of the group of DI units and J157, at the rear of the chassis deck.

When a panel pushbutton is actuated, the 5/5.1-Mc signal at J150 is the output of the group of DI units to the left of the actuated button (and the CAD if present). The 5/5.1-Mc REFERENCE signal (J157) is the output of the DI group above and to the right of the actuated button.

Therefore, it is possible to form a 1:1 Lissajous pattern between these two signals, if the dials of the two groups of DI-1 units are set to equality. (The CAD, if installed, will terminate the left-hand group and should be set at 0 or the pattern will drift). In this way, any series of dial settings of one group of DI units can be compared with the same settings on the other group.

Signals from these connectors can, of course, be compared or measured individually in any other convenient way (frequency-counter measurements, or audio-beat comparison, for instance).

5.4 REMOVAL OF MODULES FROM THE CHASSIS.

5.4.1 GENERAL.

Remove the four knurled screws on the front panel (accessible through the handles), release the cabinet clamps at the rear (if in use), and withdraw the instrument from its cabinet. (See Figure 5-2).

CAUTION

The power switch must first be OFF, or preferably, the power cord should be disconnected.

5.4.2 REMOVAL OF A DIGIT INSERTION UNIT.

Each digit unit is held in place by two front-panel screws (concealed under the dial strip at the top of the panel) and by a hold-down clamp in the deck at the rear of the unit. To remove a digit unit, proceed as follows:

- a. Remove the dial strip, which is held in place by the two Phillips-head screws at its ends.
- b. Loosen the two Allen-head setscrews in the knob, by use of a 3/32-inch hex wrench, and remove the dial. Then pull the dial lamp-holder forward out of the panel. (There is a threaded insert in the top center of the lamp-holder into which a 4-40 screw can be inserted to serve as a handle).

NOTE-DIAL INDEXING

The shaft of each digit unit has the numeral "5" stamped on it, visible when the dial is removed. When the shaft is turned so that this numeral is up, the unit is in the "5" digit position. Prior to dial remount, make sure the dial number 5 is positioned to correspond to this marking.

- c. Release the rear clamp, using a straight-bladed screwdriver in the slot of the clamp screw. Turn counterclockwise until the clamping bar swings out of the recess in the rear of the digit unit. (To reinstall the unit, it may be necessary to take an additional turn or two counterclockwise, in order to raise the clamping bar high enough to swing freely into the recess, when the clamp screw is tightened clockwise.)
- d. Grasp the unit by its shaft, and at the rear, and lift vertically for about 5/8 inch until the banana plugs are disengaged. Then continue to raise the rear and angle the unit out.

5.4.3 REMOVAL OF THE CONTINUOUSLY ADJUSTABLE DECADE, CAD.

Procedures are the same as for the removal of a digit unit, described in paragraph 5.4.2, except that the EXTERNAL CONTROL/INTERNAL LOCK switch crank must be pulled off the shaft, after the dial is removed.

CAUTION

Position this switch at EXTERNAL CONTROL before removal or remount; otherwise, the leaf-spring contact which controls lamp dimming may be damaged.

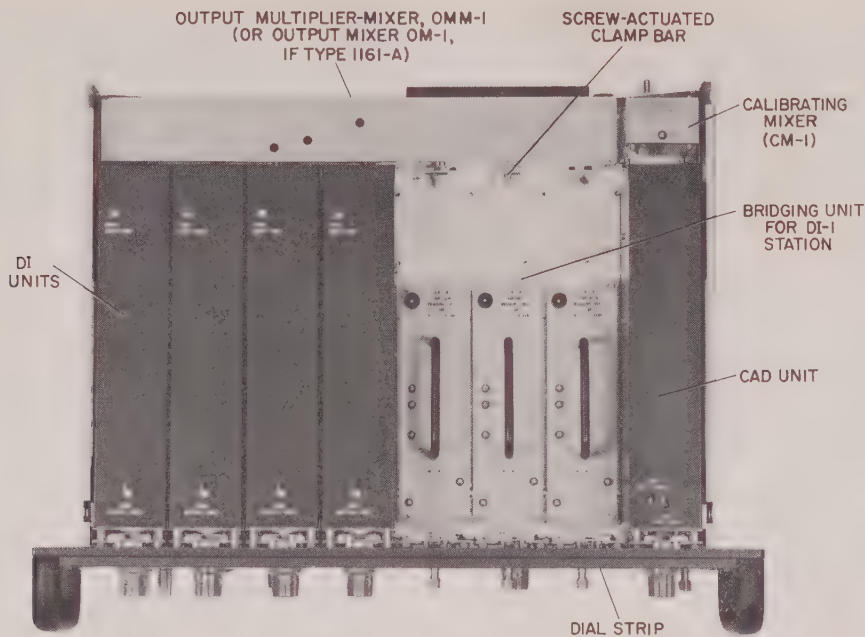


Figure 5-2. Type 1162-9524 Synthesizer top view, cabinet removed. (DI units shown less filter plugs.)

NOTE-DIAL INDEXING

To reinstall the CAD dial, turn the shaft clockwise to the stop. Then install the dial to read "11" (i.e., set the dial line marked "10" at the lamp-holder dial line marked "1", for proper dial registration).

5.4.4 REMOVAL OF THE CALIBRATING MIXER, CM-1.

Remove the three 4-40 screws from the ears at the base of the cover of the unit and lift vertically.

5.4.5 REMOVAL OF OUTPUT (MULTIPLIER) MIXER.

The Output Mixer, OM-1, (Type 1161-A, the Output Multiplier-Mixer, OMM-1 (Type 1162-A), or the Output Multiplier-Mixer, OMM-2 (Type 1163-A) is held in place by two 4-40 screws passing through the gussets on the endpans of the chassis into threaded inserts near the ends of the unit. Remove these screws, and lift the unit vertically until the banana plugs are disengaged. Small, circular posts mounted in the end plates of the unit may be used as pry-points for a screwdriver, to lift the unit clear of the banana plugs.

5.4.6 REMOVAL OF THE ANCILLARY FREQUENCY SOURCE, AFS (Figure 5-3).

This unit is held in place by two 1 1/2-inch, 10-32 screws which pass vertically through the unit into threaded inserts in the deck of the chassis. With the instrument upside down, take out these screws and lift the unit vertically until the banana plugs are disengaged.

CAUTION

Do not lift at an angle (e.g., by means of the GR874 connectors at rear only). This may damage the banana plugs. Similar precautions should be observed in removal of other modules.

5.4.7 REMOVAL OF THE POWER SUPPLY, PS-3.

This unit is secured by one 1 1/2-inch, 10-32 screw, which passes through the unit into the deck of the chassis, and by two more 10-32 screws (with special heads), which thread into the back edge of the sandwich deck. Remove these screws and lift the unit vertically until the banana plugs are disengaged.

5.5 USE OF BRIDGING UNITS.

5.5.1 DIGIT-INSERTION BRIDGING UNIT.

Each synthesizer, as delivered, is provided with a spare DI bridging unit (part number 1160-4070) and an accompanying dial-slot cover plate (part number 1160-8015) as separate accessories. If a DI unit (other than RDI-4) must be removed (for service or for any other reason), its place can be taken by the bridging unit and the synthesizer will continue to be operative, although with one less available digit.

NOTE

The 1163 synthesizer cannot operate without a properly functioning RDI-4 module.

For trouble-analysis purposes, the bridging unit may be plugged in directly in place of any removal DI unit. If it is intended to keep the bridging unit installed for some time, however, it is desirable to fill the gap resulting from removal of a DI unit. Transfer the last DI unit to the right into the vacated position and plug in the bridging unit to the right of the result-



ing continuous group of DI units. This will maintain proper correspondence between the digit steps engraved on the dial strip and the actual digit steps.

Synthesizers purchased only partially equipped have bridging units installed at the factory in each unfilled station. Figure 5-2 shows bridging units installed in such a synthesizer. Figure 1-2 shows cover plates installed to complete panel dress.

5.5.2 CAD BRIDGING UNIT.

When the CAD is omitted or removed, it is desirable (but not absolutely essential) to replace it with CAD Bridging Unit, 1160-4080. If this bridging unit is installed, the pushbuttons behave in more or less normal fashion. That is, when button B₈ or B_{CAD} OFF (see Figures 4-6 through 4-8), or the button under any unoccupied DI station in the partially equipped models, is operated, the input to the first active DI unit will be 5 Mc/s (signal component 0 kc/s). If the bridging unit is not installed and the CAD OFF button is actuated, this 5-Mc input will still be applied correctly to the first active DI unit.

NOTE

If any other button is inadvertently depressed, this proper input will not be supplied, if the CAD Bridging Unit is missing.

5.5.3 OPERATION WITHOUT BRIDGING UNITS.

The primary function of the DI bridging unit is to connect together the input and output banana plugs at the vacated position. These are the two plugs nearest the front of the deck, PL211-X and PL212-X (X is the digit station number I through VII). The bridging unit also supplies proper loading on the picket-fence line (PL208-X and PL209-X) and on the 42-Mc line (PL210-X), but this loading is not essential, particularly if only one or two DI units are missing. So, in an emergency, PL211-X and PL212-X can be connected together with a clip lead, if a bridging unit is not available, and normal operation will be achieved.

Correspondingly, signal paths can be completed to simulate the CAD bridging unit by connection of PL213 to PL216, but it is probably easier just to depress the CAD OFF button when the CAD is removed.

CAUTION

The bridging units are designed to protect the +18V banana plug (PL207-X) from accidental grounding. If a unit is removed and replaced by a clip lead instead of a bridging unit, be careful not to ground this plug.

5.5.4 COVER PLATE 1160-8015.

This cover plate, which hides the keyhole cutout in the panel when a DI or CAD unit is missing, is

held in place by one screw only, in its lower right hand corner. The left-hand-corner screwhead passes through a clearance hole in the plate.

NOTE

For removal or installation, do not remove both screws or the lamp-switching panel, which is also held by these screws, may become dislocated.

5.6 SYSTEM TROUBLE ANALYSIS.

5.6.1 GENERAL.

The modular construction used for all three synthesizers makes it relatively easy to diagnose system trouble, particularly if spare modules of the various kinds are at hand. Suggestions for determination of the module responsible for system failure follow.

5.6.2 SINGLE DIAL-LAMP FAILURE.

If one dial lamp fails at all positions of its dial and the others behave normally, the bulb is probably burned out. Remove the lamp and inspect it. If the lamp is not defective, the associated module should be checked. DI units can be compared with the CAD as described in paragraph 5.3. In the Type 1163 synthesizer, the CAD check cannot be made on the RDI-4 units. A frequency measurement at the output connector can be made to check operation of the RDI-4. If the RDI-4 lamp is out, and the frequency measurement at the output jack is normal, check the output jack with an oscilloscope for frequency jitter, indicating instability in the RDI-4 phase-lock loop (see Section DD).

Remove any defective DI unit and replace it with another, a bridging unit, or even a clip lead (refer to paragraph 5.5.3). A defective RDI-4, however, can be replaced only by another RDI-4 unit.

5.6.3 TOTAL DIAL-LAMP FAILURE.

If all dial lamps fail simultaneously, the trouble is probably in the power supply. If the synthesizer is otherwise behaving properly, a wiring fault in the chassis-lamp circuits should be suspected. Also a defective AFS unit can sometimes cause all lamps to go out because of improper frequencies on the picket-fence or 42-Mc lines (refer to paragraph 5.6.4).

In the Type 1163, if all DI lamps go out, but the RDI-4 lamp does not, the 42-Mc and picket-fence section of the AFS unit can still be faulty. Failure in the 1-Mc section of the AFS can also cause total lamp failure, or an apparent RDI-4 failure (in the Type 1163).

5.6.4 IMPROPER FREQUENCY GENERATION.

If lamp behavior is normal, but the self-check (refer to paragraph 5.3) or other test indicates improper frequency generation, the trouble is probably in the AFS unit, but might be in some DI unit.

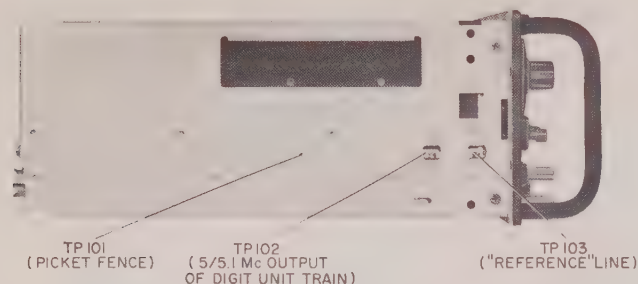


Figure 5-3. Synthesizer left-hand side view, cabinet removed (Types 1161 or 1162).

NOTE

A dial may have been installed with improper registration (refer to paragraph 5.4.2).

If the first DI (number 7 in a complete unit) seems to agree properly with the CAD dial under self-check procedures of each of its digits, proceed through the DI train from right to left, checking each unit in turn, until the defective one is found. If this procedure fails to locate the trouble (and particularly if the number 7 DI doesn't check closely with the CAD), then test the AFS (or replace it if a spare is available).

5.6.5 FREQUENCY 10X OR 0.1X (TYPE 1161 or 1162).

If the output frequency is tentimes (or one-tenth) the dial indication, the wrong dial strip has been installed in reassembly. A check that the dial strip corresponds with the installed OM-1 or OMM-1 (Type 1161-A or Type 1162-A, respectively) can be done entirely from the front of the instrument. Set up 2 c/s on the dials, throw the MONITOR switch to OUTPUT VOLTS, with AC OUTPUT COUPLING selected, and OUTPUT LEVEL at maximum. If all is proper, the MONITOR meter will follow the 2-cycle output frequency. The indication will be near the zero end of the scale, because the cutoff for ac coupling is at 30 c/s. (Incidentally, this test also checks the 0's of all the DI units to the left of the 1-cycle-per-step position.)

5.6.6 INADEQUATE "CRYSTAL FREQ" RANGE.

The CRYSTAL FREQ control on the front panel permits relatively fine control of the free-running frequency of the internal master crystal oscillator. There is also a coarse control, which can be adjusted slightly, if for any reason the range of the panel control proves inadequate. The coarse control is C128, accessible through the bottom of the AFS unit, without removal of the unit from the chassis. To readjust this control, first set the fine control approximately at center. Then, measure the (free-running) output at the rear-apron connectors, 5 MC OUT (J108) or 100 KC OUT (J206), while making the adjustment.

NOTE

Use a nonmetallic screwdriver.

5.6.7 OUTPUT MISSING OR ABNORMALLY LOW.

First confirm that the OUTPUT COUPLING switch is in the AC position, if the MONITOR meter is being used for output-voltage indication. If trouble persists with this control properly set, the fault may be in the final DI unit, in the chassis wiring (including the push-button switches), in the output-mixer module that is installed, or in the output amplifier. If the final DI is at fault, the self-check (refer to paragraph 5.3) will probably fail at button B₁.

Look for $+18 \pm 0.2$ Vdc at J153 (rear apron) to ascertain that B+ is available from the power-supply module. If the reading is abnormal, refer to Sections BA or BB plus GC.

If B+ is present, look for the indications called for in Table 5-1 at externally available test points. With three exceptions, these trouble-analysis observations can be made at rear-apron test points and will not require instrument disassembly. However, for access to TP101, TP102 and AT201, the synthesizer must be removed from its case. These observations will help to isolate malfunction to the module level. Detailed module service instructions are given in the referenced, tabbed sections that follow.

For the observations called for in Table 5-1 the synthesizer should be synchronized with the 100-kc time base of the counter, which should be connected to LOCK SIG IN (J107 on the rear apron). Alternative trouble analysis techniques are presented in Table 5-2.

5.7 SERVICE AT THE MODULE LEVEL.

A thorough knowledge of the principles of operation, and of all the circuit arrangements by which the desired operation is achieved, is required for detailed trouble-shooting in this equipment. In separate sections of this book will be found additional descriptive matter on the principles of operation of the Main Frames and of each of the module types used in the synthesizers, together with photographs, circuit diagrams, and parts lists. Instrument servicing is relatively easy, since suspected modules can so readily be replaced by known good ones or, in the case of the DI or the CAD, jumpered out. Repair service on modules can be obtained at the factory or, in most instances, at the nearest General Radio District Office (see rear of manual).



TABLE 5-1

SYSTEM TROUBLE ANALYSIS

<i>Test Points</i>	<i>Synthesizer Type</i>	<i>Normal Indications*</i>	<i>Modules Involved</i>	<i>If Indication Abnormal,† Refer to Section</i>
J150	1161/2/3	5.0 Mc/s plus 10 kc/s x DI-1 dial readings	DI, AFS	DI, CB
J151	1161/2/3	5.0 Mc/s	AFS	CB
J152	1161/2/3	1.0 Mc/s	AFS	CB
J154	1162/3	50/51 Mc/s (10X J150)	OMM-1, OMM-2, DI, AFS	FB, FC DI, CB
J155	1161/2/3	42 Mc/s	AFS	CB
J156	1162	50 Mc/s	OMM-1, AFS	FB, CB
J156	1163	50 Mc/s minus 1 Mc/s x RDI-4 dial reading	RDI-4, AFS	DC, CB
J157	1161/2/3	5.0 Mc/s +10 kc/s x "replaced" DI dial readings	DI, AFS	DI, CB
AT201	1161	Synthesizer output frequency	OM-1, OMM-1, OMM-2	FA, FB, FC
TP102	1161/2/3	5.0 Mc/s +10 kc/s x CAD major division‡	CAD	EA
J403A	1161/2/3	CAD output frequency minus "replaced" DI output frequency	CM-1	EA
TP101	1161/2/3	Picket Fence waveform (Figure 5-4)	AFS	CB

NOTES:

*Frequencies above can be measured with a sensitive (0.1 V) 50-Mc counter or counter/scaler combination such as a GR Type 1191-Z (100). Use an oscilloscope (such as Tektronix 543 with C/A plug-in) for the waveform at TP101.

†If signals are absent completely, chassis shorts or opens may be causing difficulty; see Sections BA or BB.

‡With B1 depressed; (B2 in Type 1163).

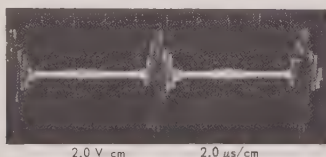


Figure 5-4.
Picket-Fence waveform at TP101.

TABLE 5-2

SYSTEM TROUBLE ANALYSIS – ALTERNATIVE
OSCILLOSCOPE LISSAJOUS PATTERN TECHNIQUES

<i>Rear Apron Test Points</i>	<i>Synthesizer Type</i>	<i>Normal Indication Frequencies – Mc/s</i>		<i>Modules Involved</i>	<i>If Indication Abnormal, Refer to Section</i>
		<i>V</i>	<i>H</i>		
J108, J152	1161/2/3	5	1	AFS	CB
J155, J152	1161/2/3	42	1	AFS	CB
J156, J152	1163	39/50	1	RDI-4	DD
J108, J156	1162	50	5	OMM-1	FB
J108, J206	1161/2/3	5	0.1	AFS	CB

NOTES: Patterns should be stationary and jitter free.
Use an oscilloscope (such as Tektronix 543, with C/A plug-in).

— TABLE 5-3 —
TEST EQUIPMENT

TABLE 5-3	
TEST EQUIPMENT	
<u>Instrument</u>	<u>Recommended Type*</u>
Fixed Attenuator, 20 dB	GR 874-G20L
Tee, coaxial	GR 874-TL
Termination, 50- Ω , coaxial	GR 874-W50BL
Digital Frequency Meter	GR 1191
Distortion and Noise Meter	GR 1932
Metered Variac® Autotransformer	GR W5MT3AW
Coaxial Patch Cord	GR 874-R22LA
Coaxial Adaptor, GR874-to-BNC Jack	GR 874-QBPA (3 required)
RF Voltmeter	GR 1820 with 1820-P2 plug-in
RF Distortion Meter	Boonton, 85C
Wave Analyzer	Hewlett-Packard 310
Oscilloscope	Textronix 547 with 1A1 Vertical Plug-in and P6008 10X probe.
Volt-Ohmmeter	Simpson 260
Patch Cord	GR 776-B

*or equivalent

5.8 MINIMUM PERFORMANCE STANDARDS.

5.8.1 GENERAL.

The following tests are provided to demonstrate synthesizer compliance with the published specifications at incoming inspection or following repair or calibration. The specific model described in these tests is the 1162-9527 synthesizer, which includes seven DI units and the CAD. These tests can be interpreted for other models and their variations by extracting the basic method and modifying it for the synthesizer at hand.

5.8.2 TEST EQUIPMENT.

The items listed in the Table 5-3 are recommended for performance of the ensuing tests.

5.8.3 OUTPUT FREQUENCY RANGE.

The System Self-Check of paragraph 5.3 offers convenient procedures to verify generation of proper frequencies. Connect equipment as shown in Figure 5-5 and make additional checks as follows:

Connect the output of the synthesizer to the counter. Use the GR 874-OBPA Adaptor to attach the

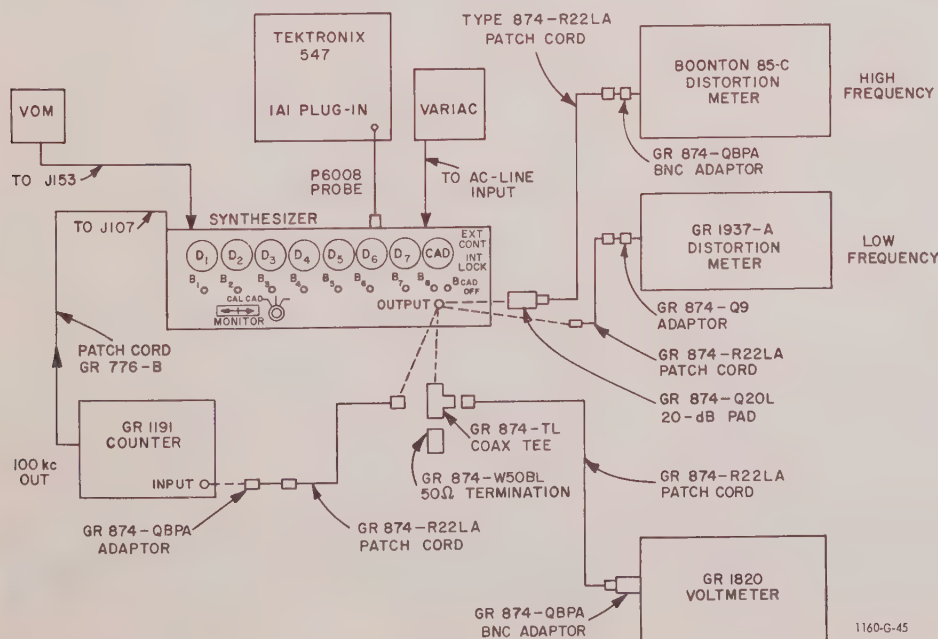


Figure 5-5. Test setup.



TABLE 5-4
CAD CHECK
(All DI dials set to "9")

<i>Cad Position</i>	<i>Cad Setting</i>	<i>Counting Time (Seconds)</i>	<i>Reading Digits</i>
1	5.0	.01	0.5000 MHz
2	5.0	.01	0.9500 MHz
3	5.0	.01	0.9950 MHz
4	5.0	.1	999.50 kHz
5	5.0	1	999.950 kHz
6	5.0	10	999995.0 Hz
7	5.0	10	999999.5 Hz
8	0.0	10	999999.9 Hz
8	10	10	1000000.0 Hz

GR874 patch cord to the counter. Connect the 100-kHz OUTPUT of the counter time base to the LOCK SIG IN (J107) of the AFS. (For counter-type frequency measurements, the time-base for counter and synthesizer must be locked together, if the results are to be meaningful at extreme resolution).

a. Set the meter function switch to LOCK TO EXT STD.

b. Adjust the synthesizer CRYSTAL FREQ control (front panel) for a locked condition (center reading on the MONITOR meter with deflection adjustable smoothly around center by means of the CRYSTAL FREQ control).

c. Set all the DI dials to "9".

d. Push in the CAD OFF button.

e. Set the counter to measure frequency with the appropriate counting times. The counter should indicate 999,999.5 kHz ± 1 count. (A 10-second counting time will be required to display the X0.1-Hz digits; 0.01 second will be needed to see the X100 kHz digits.)

f. Repeat these observations at step digit settings for 500.0000-kHz and 50 Hz. At the 50-Hz setting, vary the position of the rightmost step digit and observe the variation in the counter indication to the same tolerance.

To check the CAD pushbutton switches (main signal path), reset the step-digit dials to all 9's. With the CAD mode switch set to INT LOCK, set the CAD dial to "5.00", push in the button under DI #7 (rightmost DI). Measure the frequency as above to be 999,999.5 Hz (10-second counting time). Repeat for remaining pushbuttons. For any or all of these settings ascertain that the digit supplied by the CAD ("5" in the examples) corresponds to the CAD dial setting, by changing the CAD tuning and verifying that the counter follows the variations. The counter digits "50" in Table 5-4 may read anywhere within the range from 49 to 51 (when the CAD is set exactly at 5.0),

without exceeding CAD calibration tolerance. Variations of ± 1 in the final digit may also be noted, caused by the ± 1 count uncertainty characteristic of counters.

The above series of checks serve the primary function of assuring that the signal paths through the CAD pushbutton switches are functioning properly. To confirm that the "CAD CAL" frequency-reference circuits of these switches are also correct, use the procedures of paragraph 5.3.

5.8.4 OUTPUT AMPLITUDE.

a. Set the frequency of the synthesizer to 500.0000 kHz; CAD OFF, OUTPUT COUPLING at AC.

b. Connect the GR874-TL and GR874-W50BL to the OUTPUT connector of the synthesizer.

c. Connect the 1820 Voltmeter to the GR874-TL.

d. Adjust the synthesizer OUTPUT LEVEL control for an indication of 2.0 V on the 1820 Voltmeter.

e. Set the dials to 999,999.9, then set them to read 50 Hz.

The response variation as indicated by the 1820 Voltmeter, from the lowest indication to the highest, must be less than 2 dB.

f. Reset the frequency of the synthesizer to 500.0000 kHz.

g. Set the OUTPUT LEVEL control fully counterclockwise with the MONITOR-meter switch at OUTPUT VOLTS.

h. The panel meter must indicate zero (± 1 linewidth on the meter scale).

i. Adjust the OUTPUT LEVEL control for an indication of 2.0 volts on the 1820 Voltmeter. The MONITOR meter should read 2.0 volts within the width of a scale marking.

5.8.5 SPURIOUS FREQUENCY OUTPUTS.

Harmonic Distortion.

- a. Connect the Distortion Meter to the GR874-TL.
- b. Set the frequency of the synthesizer to 15.0000 kHz.
- c. Adjust the OUTPUT LEVEL control for a panel-meter indication of 2.0 volts.
- d. Calibrate the Distortion Meter and measure the distortion.
- e. The distortion must be at least 40 dB below signal. (30 dB for 1163)
- f. Remove the Distortion Meter, Type 874-TL and Type 874-W50BL from the output connector.
- g. Connect a Type 874-R22LA to the OUTPUT connector and connect the distortion meter to the Type 874-R22LA, via the Type 874-G20L Pad and the Type 874-QBPA Adaptor.
- h. Set the frequency of the synthesizer to 999.9999 kHz.
- i. Measure the distortion at 2.0 volts output to be down at least 40 dB below signal. (30 dB for 1163)
- j. Remove the distortion meter and the Type 874-R22LA from the synthesizer.

Nonharmonic Distortion.

- a. Connect the HP Model 310 Wave Analyzer to the OUTPUT connector of the synthesizer.

TABLE 5-5

**TYPE 1162 SYNTHESIZER
REPRESENTATIVE SPURIOUS OUTPUTS**

<i>Test</i>	<i>Synthesizer Dial Freq (kHz)</i>	<i>Analyzer Tuning (kHz)</i>
1	8	5.6
2	60	6
3	60	40
4	60	160
5	260	160
6	260	226
7	460	352
8	460	446
9	660	654

- b. Set the controls as follows:

ABSOLUTE-RELATIVE switch - RELATIVE
 MAX INPUT VOLTAGE switch - 1
 BANDWIDTH switch - 200
 RANGE (DB) switch - 0
 MODE switch - NORMAL

TABLE 5-6

SPURIOUS ANALYSIS BY TEST NUMBER - TYPE 1162

<i>Test</i>	<i>Spurious* Class</i>	<i>F_o</i>	<i>F_s</i>	<i>Signals (kHz)</i>				<i>Mechanism</i>
				Δf_s	$(f_o)_1$	$(f_d)_1$	$(f_o)_2$	
1	3/5	8	5.6	2.4	5000.8	3000	—	$3 \times 5000.8 = 15002.4$ $5 \times 3000 = 15000.0$ $\Delta f_s = 2.4$
2	F. T.	60	6	54	5006	—	5060	5060-5006 = 54
3	100 kHz	60	40	100	—	—	—	$F_s = \pm(F_o \pm \Delta f_s)$ $= -(60 - 100) = 40$
4	100 kHz	60	160	100	—	—	—	$F_s = \pm(F_o \pm \Delta f_s)$ $= +(60 + 100) = 160$
5	100 kHz	260	160	100	—	—	—	$F_s = \pm(260 - 100) = 160$
6	F. T.	260	226	34	5026	—	5060	5060-5026 = 34
7	2/3	460	352	108	5046	3400	—	$2 \times 5046 = 10092$ $3 \times 3400 = 10200$ 108
8	F. T.	460	446	14	5046	—	5060	5060-5046 = 14
9	F. T.	660	654	6	5066	—	5060	5066-5060 = 6

*See Table 5-7



- c. Set the synthesizer dial to 008,000.0 kHz.
- d. Push in the CAD OFF button.
- e. Tune the FREQUENCY controls of the wave analyzer around 8 kHz for peak indication of the analyzer meter.
- f. Adjust the OUTPUT LEVEL control of the synthesizer to make this peak indicate 0 dB on the analyzer meter.
- g. Retune analyzer to 5.6 kHz and measure the spurious level at this frequency.
- h. In similar fashion set the dials according to the Table 5-5 and measure spurious-frequency amplitudes at the indicated frequencies.
- i. The spurious output levels as indicated by the analyzer meter must be at least -60 dB relative to signal.

5.8.6 MISCELLANEOUS MEASUREMENTS.

- a. Connect the synthesizer to the Wattmeter-Variac, set to 117 V ac. Turn on all the dial lights by pushing in the pushbutton under the CAD. The input power as indicated by the wattmeter must not exceed 55 W.
- b. Use the oscilloscope to check that there is an rf output of at least 0.1 V across $1k\Omega$ at all appropriate jacks on the rear apron, at frequencies as specified at the jacks.
- c. Observe $+18 \pm 0.2$ Vdc at J153 on the rear apron with the volt-ohmmeter.

5.8.7 PROGRAMMABLE OPERATION TEST.

Prepare the synthesizer for programmable operation as called for in the DI instructions and perform frequency checks at will.

TABLE 5-7
SPURIOUS FREQUENCY CLASSES

<u>Class</u>	<u>Δf_s (kHz)</u>	<u>Remarks</u>
100 kHz	$\pm(F_o \pm 100)$	"Picket-fence" spacing is 100 kHz
2/3	$\pm(2f_o - 3f_d)_1$	Internal in #1 DI
3/5	$\pm(3f_o - 5f_d)_1$	Internal in #1 DI
F. T.	$\pm(f_o)_1 - (F_o)_2$	Output-input frequencies of #1 DI

Δf_s = Spacing between desired signal and spurious sideband
 $= \pm(F_o \pm F_s)$

F_o = Synthesizer output signal frequency = $10(f_o)_1 - 50$ MHz

F_s = Synthesizer output spurious frequency = $\pm(F_o \pm \Delta f_s)$

$(f_o)_1$ = Frequency of output oscillator of DI unit in first station

$(f_d)_1$ = Frequency of digit oscillator of DI unit in first station

$(f_o)_2$ = Frequency of output oscillator of DI unit in second station

F. T. = Feedthrough

section AA

ACCESSORIES

P/N 1160-4070 and 1160-4080

AA-1.1 GENERAL.

Accessory equipments covered in this section are all units peculiar to General Radio synthesizers. Most mount directly on the Main Frame chassis, either in place of standard modules, or as additions to the standard system configuration. With the exception of the DI-1 Bridging Unit, one of which is supplied with each synthesizer for a service spare, accessory equipments are optional extras.

On synthesizers purchased less than fully equipped, each unoccupied DI-1 station is furnished with a bridging unit. The same situation obtains for an unoccupied CAD station.

AA-1.2 BRIDGING UNITS.

The DI-1 Bridging Unit (P/N 1160-4070) is shown in Figure AA-1 and the schematic diagram appears in Figure AA-2. The CAD Bridging Unit (P/N 1160-4080) schematic is shown in Figure AA-3.

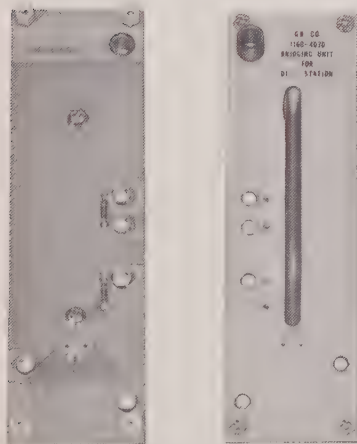


Figure AA-1. Bridging Unit for DI (P/N 1160-4070).

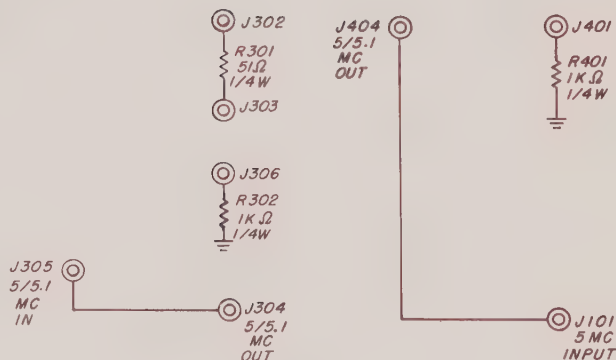


Figure AA-2. Schematic diagram for DI Bridging Unit.

Figure AA-3. Schematic diagram for CAD Bridging Unit.

Parts List for DI Bridging Unit (Figure AA-2).

REF NO	DESCRIPTION	PART NO
J302	JACK, etched-circuit type	1160-6110
J303	JACK, etched-circuit type	1160-6110
J304	JACK, etched-circuit type	1160-6110
J305	JACK, etched-circuit type	1160-6110
J306	JACK, etched-circuit type	1160-6110
R301	RESISTOR, 51 Ω ±5% 1/4 W	6099-0515
R302	RESISTOR, 1 kΩ ±5% 1/4 W	6099-2105

Parts List for CAD Bridging Unit (Figure AA-3).

REF NO	DESCRIPTION	PART NO
J101	JACK, etched-circuit type	1160-6110
J401	JACK, etched-circuit type	1160-6110
J404	JACK, etched-circuit type	1160-6110
R401	RESISTOR, 1 kΩ ±5% 1/4 W	6099-2105

GENERAL RADIO COMPANY

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SERVICE INSTRUCTIONS

section **BA**

MAIN FRAME & OUTPUT AMPLIFIER

P/N 1160-4060
Chassis for Types 1161 and 1162 Synthesizers
(Including Output Amplifier P/N 1160-4040)

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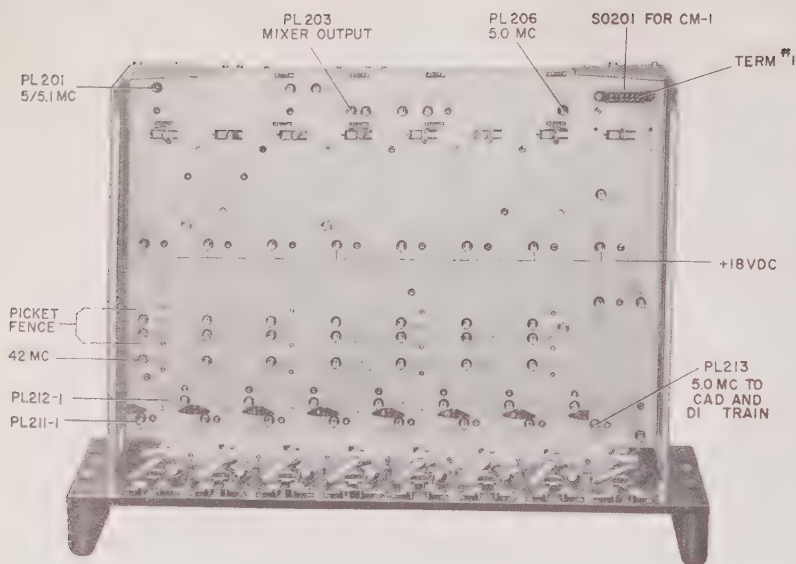


Figure BA-1.
Synthesizer Main Frame - top deck of chassis.
Callouts indicate important module-interconnection points.

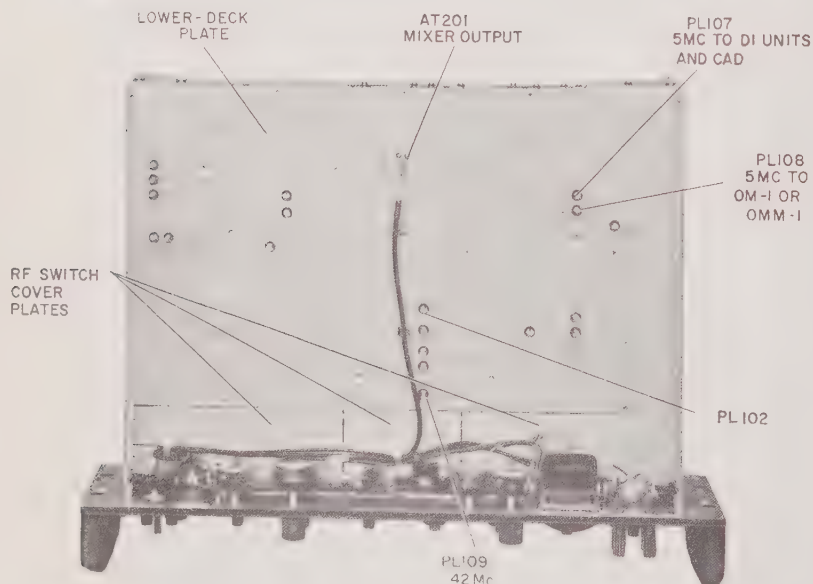


Figure BA-2.
Synthesizer Main Frame - lower deck of chassis.
Callouts indicate important module-interconnection points.

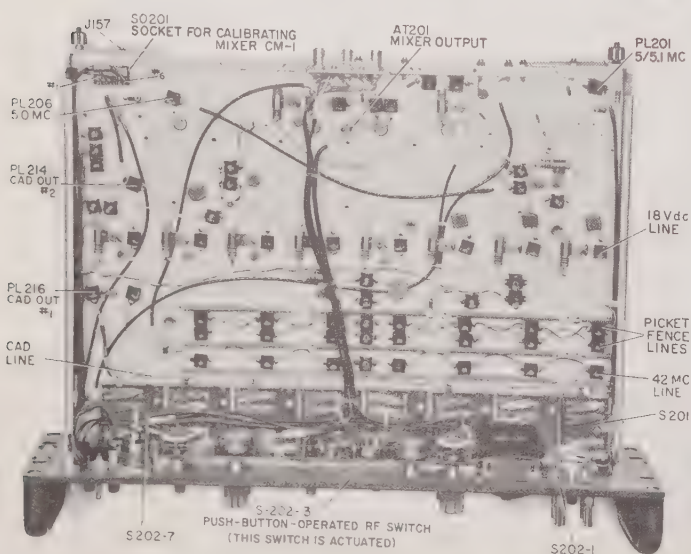


Figure BA-3.
Chassis lower deck with cover plates removed.

CAUTION

Do not connect dc potentials to the synthesizer output connector, or damage to the Output Amplifier may result.

SECTION BA-1

INTRODUCTION

BA-1.1 GENERAL.

Familiarity with the material contained in Sections 1 through 5 of the front part of this book is assumed. The separated subassemblies are treated in individual sections such as this.

BA-1.2 PURPOSE.

The Main Frame (Part No 1160-4060) is the foundation unit of both the Type 1161-A and Type 1162-A synthesizers. It provides mounting facilities for the plug-in modules and proper interconnections between them so that the assembly will perform as described in Sections 1 through 5 at the front of this book.

Figure BA-9, the over-all schematic, is the system interconnecting wiring diagram for the complete synthesizer.

A part of the interconnection function performed by the chassis involves rf switching, which makes it possible for the CAD unit to replace, functionally, any chosen group of DI units. Corresponding dial-light switching is also included. To constitute an operating synthesizer, the Main Frame must be equipped with a train of DI units (normally between three and seven), an AFS unit, a Power Supply, and either an OM-1 unit (for Type 1161-A) or an OMM-1 (for Type 1162-A); the CAD unit is optional.

The Main Frame is comprised of the chassis and the output amplifier. The chassis is so designed that similar modules can be interchanged with one another. In any DI station that is intentionally left vacant, a DI Bridging Unit (P/N 1160-4070) or equivalent must be installed. If the CAD unit is omitted, it is desirable (but not necessary) to replace it by a CAD Bridging Unit, P/N 1160-4080. Refer to paragraphs 3.9 and 5.5 in the front portion.

In addition to these interconnection and switching functions, the chassis mounts the Output Amplifier (P/N 1160-4040), which is an integral part of the Main Frame. This amplifier accepts signals from either

the OM-1 or the OMM-1 (Type 1161-A or 1162-A) and suitably amplifies them for delivery to the synthesizer OUTPUT connector.

BA-1.3 DESCRIPTION.

BA-1.3.1 SANDWICH DECK.

The main structural parts of the chassis are the instrument front panel, two end pans to support the deck ends, and the deck itself. The deck consists of two horizontal plates, spaced 5/16 inch apart to form a "sandwich." Mounted on the plates, and captive within the sandwich, are a number of banana plugs with special molded insulating bases. Each plug is free to move a small amount horizontally, for alignment with the proper jack in the associated plug-in module. Some of the banana plugs project through the top surface of the deck to make connections to the DI modules, the OM-1 (or the OMM-1), and CAD; others protrude through the bottom surface to engage the AFS Ancillary Frequency Source and the PS-3 Power Supply. Figures BA-1 and BA-2 show top and bottom views of the sandwich.

Also included within the sandwich are the flat-bladed rotary rf switches linked with the panel push-buttons. These control the functional position of the CAD and connect the output of the replaced DI units to the calibrating mixer, as described in the front portion of this book, paragraphs 3.3.1 and 4.5. These switches are accessible for inspection if the three cover plates, which form the front portion of the bottom deck of the sandwich, are removed. These plates can be seen in Figure BA-2.

Figure BA-3 is a view of the bottom, similar to Figure BA-2, but with the three cover plates and the main lower deck-plate taken off. The eight rf switches can be seen in a row next to the front panel. The fifth switch from the left has been actuated through its panel pushbutton. Note the different orientation of the blades of the switch.

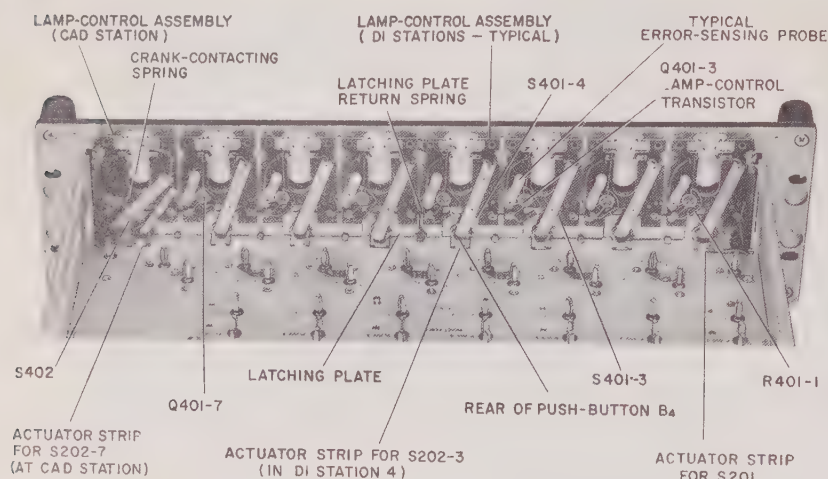


Figure BA-4.
Behind-panel view (above chassis deck) of Main Frame showing details of lamp control assemblies.

In Figure BA-3 the banana plugs are visible, as well as the interconnecting wiring. Some of the plugs are identified in Figures BA-1 and BA-2, and the appropriate "PL-" number for each is marked on the sandwich plates (top and bottom).

BA-1.3.2 DIAL-LIGHT SWITCHES.

Figure BA-4 shows the top rear of the front panel, on which are mounted with lamp-panel assemblies. Seven of these are identical, at the DI stations. Each contains provisions for a dial-light assembly (see Figure BA-5).

The dial-light assembly makes a spring engagement with the pair of pins that protrude through the top of the keyhole slot in the instrument panel, to form one side of the lamp circuit. The high side of the circuit to the lamp is completed by the U-spring near the slot center, which grips the bulb reflector-holder.

Switches S401-1 through S401-7 control the dial lights at the DI stations and S402 controls the CAD dial light. These switches are operated by the panel pushbuttons, which simultaneously throw the rf switches S201 and S202-1 to S202-7. The actuator strip for S202-3 is identified in Figure BA-4.

The short sheet-metal springs, called Error-Sensing Probes in Figure BA-4, in cooperation with Lamp-Control Transistors Q401-1 to Q401-7, extinguish the corresponding dial lights in case of DI malfunction (refer to Section DI, on the RDI-1B unit, for details).

The eighth lamp panel, at the CAD station, has no error-sensing probe or transistor. The dial-light switch for the CAD is S402, which is opened when the CAD OFF button is pushed. Rf switch S202-7, at the CAD station, is operated by the pushbutton centered under the CAD station (Figure BA-3).

The CAD lamp panel also carries a leaf-spring that, in combination with the CAD EXTERNAL CONTROL-INTERNAL LOCK crank (refer to Section EA and the chassis schematic, Figure BA-9) makes up S404, which dims the CAD dial light in the EXTERNAL CONTROL position.

The eighth switch from the left in Figure BA-3 (S201) is the same as the other seven, except that the portion of the etched board, which in other switches carries the banana plug for connection to the next succeeding DI unit, has been removed. The output from S201 is taken instead via coaxial cable to PL201 at the rear of the chassis. The part number of this switch assembly for DI station 1 is 1160-2741.

BA-1.3.3 PUSHBUTTONS.

The front-panel pushbuttons (B₁ to B₈ and B CAD OFF of Figure 4-7), shown in the front-panel view of Figures 1-1 and 1-2, are so arranged mechanically that in normal operation only one button can remain depressed at a time. Operation of any button releases any other, which has previously been actuated, to its normal, nonoperated position. Each button from B₁ to B₇, inclusive, operates two switches. For example, in Figure BA-4, lamp switch S401-4 is opened and rf switch S202-3 is operated, when button B₄ is pushed.

Button B₈, as can be seen in Figure BA-9, operates only S202-7, and B CAD OFF operates only lamp switch S402.

Figure BA-6 is a sectional view of one of the pushbutton controls, in its relationship to typical switches. The restoring force on the pushbutton body

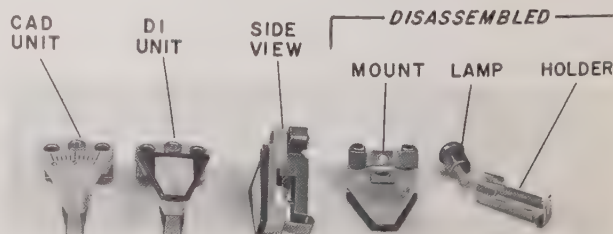
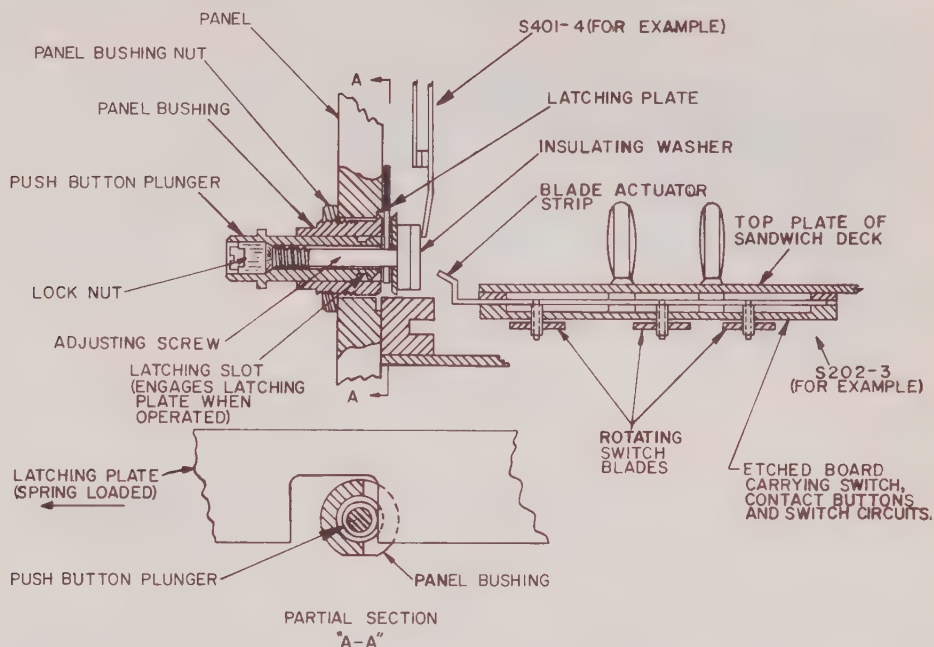


Figure BA-5.
Digit-station dial-lamp panel inserts (typical).

Figure BA-6.
Section view for a
typical front-panel
pushbutton-switch-
control assembly.



is supplied by the blade of S401, and S202 is held in its nonoperated position by its own restoring spring (shown in Figure BA-7). The latching plate, which runs horizontally across the panel in Figure BA-4, is shown in vertical section in Figure BA-6. It has a rectangular cutout at each pushbutton position and one edge of this cutout bears on the contoured pushbutton body.

When the button is pushed, the latching plate is forced to move horizontally as the edge of the cutout rides up the conical end of the pushbutton body; it then falls back into the latching slot and holds the pushbutton in its operated position.

The mechanical throw of switch S202 is factory adjusted in this operated position by the adjustable plunger in the pushbutton body.

As any button is pushed, the resulting lateral motion of the latching plate releases it from the latch-

ing slot of any other button that was previously pushed, allowing that button to fall back to normal position.

The latching plate is spring loaded into the latching slots by the wire spring shown at the center of the panel in Figure BA-4.

BA-1.3.4 OUTPUT AMPLIFIER — 1160-4040.

The Output Amplifier assembly is mounted against the lower rear of the front panel, as seen in Figure BA-8. In addition to the actual amplifier circuits, this board contains (and is mounted to the panel by) the OUTPUT LEVEL control (R401), the CRYSTAL FREQ control (R407), the OUTPUT COUPLING switch (S412), and the MONITOR switch (S411). In addition, the output-voltmeter circuits are mounted on this board.



SECTION BA-2

PRINCIPLES OF OPERATION

NOTE

Refer as required to the schematic diagrams of the Main Frame, Figure BA-9, and of the Output Amplifier, Figure BA-10.

BA-2.1 GENERAL.

The Main Frame serves to interconnect the modules of the synthesizer to produce an operating unit. In order to explain these interconnections, it is first necessary to comment briefly on the functioning of these various modules.

In Figure 4-1 of the main section of this book there appears a block labeled "Frequency Synthesizing Circuits." The separate kinds of modules included in this block will now be considered. The modules involved are:

1. AFS Ancillary Frequency Source,
2. DI Digit-Insertion Unit,
3. CAD Continuously Adjustable Decade.

BA-2.2 AFS CONNECTIONS—SIGNAL CIRCUITS.

The primary function of the AFS Unit is to supply a "starting" frequency of 5.0 Mc/s to the first DI unit in a train of DI units and to the CAD unit, to supply a signal at 42 Mc/s to all DI units and to the CAD unit, and to provide a "picket fence" of frequencies (spaced at 100-kc intervals from 3.0 to 3.9 Mc/s) to all installed DI units.

NOTE

Discussion of how these frequencies are employed in the DI units and in the CAD unit will be found in Sections DI and EA of this book. Analysis of the method by which these frequencies are coherently derived in the AFS is provided in Section CB.

Figure 4-6 and 4-7 of the main section of this book show the signal path through the DI units and pushbutton-operated switches. The input and output connections to each DI for this signal path are provided by the series of banana plugs, PL211-X and

PL212-X, visible nearest the panel in Figure BA-1. These plugs are integral parts of the rf switch assemblies previously noted (Figures BA-3 and BA-7). PL212-1 through PL212-7 are signal-input connectors to the several DI units; PL211-1 through PL211-7 are the corresponding outputs. The connection of the 5.0-Mc starting frequency (from the AFS unit to the sandwich) is furnished by PL107 (Figure BA-2).

In order to perform its function, each DI must receive a 42-Mc input and a picket-fence input. The 42-Mc output from the AFS enters the sandwich via PL109 (Figure BA-2), whence it is distributed to the DI units by way of PL210-1 to PL210-7, and to the CAD by PL210-8 (Figure BA-1). The picket fence is delivered push-pull at plugs PL105 and PL106 (Figure BA-2) and distributed on the parallel lines through PL208-1 to PL208-7 and PL209-1 to PL209-7 (Figures BA-1 and BA-3).

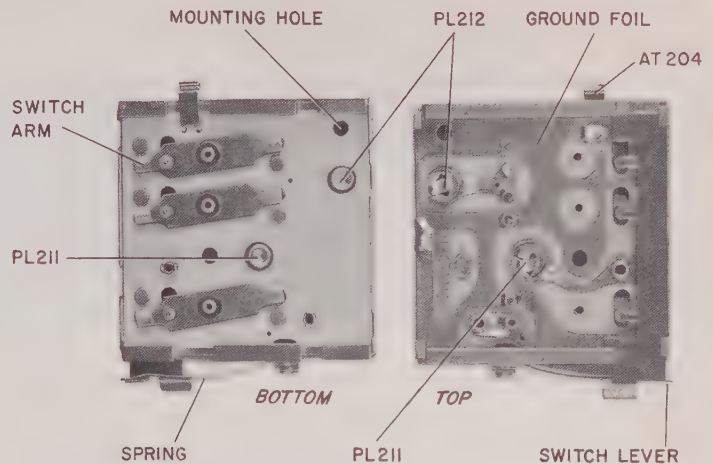
As indicated in Figure 4-1, 5.0 Mc/s is also delivered, in the Type 1161-A, to the Output Mixer module OM-1 or, in the Type 1162-A, to the Output Multiplier Mixer OMM-1. This 5-Mc output from the AFS is isolated from the starting 5 Mc/s in the AFS and delivered independently to the sandwich, at PL108 (Figure BA-2), which is directly connected to PL206 (Figure BA-1).

The only other rf output from the AFS into the sandwich is 1.0 Mc/s via PL101. Although this signal is not made use of in the Types 1161-A and 1162-A synthesizers, it is available (after a 1000-ohm isolating resistor) at J152 at the rear edge of the sandwich.

BA-2.3 AFS CONNECTIONS—AUXILIARY CIRCUITS.

There are four other banana-plug connections between the AFS and the sandwich. PL111 carries a connection from CRYSTAL FREQ control potentiometer R407 (Figure BA-8) to the Master Frequency Section of the AFS (see Section CB for details). PL110 connects

Figure BA-7.
Special rf switch assembly used
in S202-1 through S202-7.



the error voltage of the AFS crystal-lock phase detector to the MONITOR meter circuits via the Output Amplifier. Two independent +18-volt supply inputs to the AFS enter via PL102 and PL103 (Figure BA-2).

BA-2.4 CAD AND CM-1 CONNECTIONS.

In addition to the +18-volt input, there are five other plug connections between the sandwich and the CAD (see Figures BA-1 and BA-3). One is 5.0 Mc/s, which is the same as the starting-frequency connection to the DI train discussed in paragraph BA-2.2. This plug, PL213, is an integral part of rf switch S202-7. Another connection is the EXTERNAL CAD CONTROL input to the CAD, via PL217, which is directly connected to the front-panel binding post marked for this function.

The 42-Mc input connection via PL210-8 is directly in parallel with PL210-1 to PL210-7, discussed in paragraph BA-2.2. There are two outputs at the CAD frequency (between 4.99 and 5.11 Mc/s, continuously variable; see Section EA.) One of these, already mentioned, is PL216 and connects via the CAD LINE to the array of rf switches (see Figure BA-3 and Figure 4-7). The other CAD output, at PL214, connects to terminal 1 of SO201 (Figure BA-3 or BA-1). SO201 receives the Calibrating Mixer module CM-1, the use of which is described in paragraph 4.5 and in Section EA.

The other input to the Calibrating Mixer is the REF LINE shown in Figures 4-6 and 4-7. This line runs along the side of the rf switches opposite the CAD LINE. It is not visible at the switches in Figure BA-3, as it is buried in a recessed slot in the front support bar of the sandwich, but its coaxial-line connection to terminal 6 of SO201 can be seen.

BA-2.5 OUTPUT CONNECTIONS.

From Figure 4-1 plus Figures 4-6 and 4-7, it can be seen that the signal output of the synthesizing circuits connects to the OM-1 (Type 1161-A) or the OMM-1 (Type 1162-A). The actual connection, shown in Figure BA-3, is by a coaxial cable from S201 to

PL201. The other input to the OM-1 (or OMM-1) — 5.0 Mc/s at PL206 — has already been discussed. The internal circuitry of the OM-1 will be found in Section FA and the OMM-1 circuitry in Section FB.

In either case, the output of the final mixer, f_o , is taken at PL203 (Figure BA-1), which connects to AT201 through the bottom deck (Figure BA-3) and is carried by coaxial cable to AT411 at OUTPUT LEVEL potentiometer, R401 (Figure BA-8).

The 5.0-Mc input at PL206 is also connected (through a 1-k Ω resistor) to J151 and the 5/5.1 Mc/s at PL201 similarly is available, through a 1-k Ω series resistor, at J150.

Two other outputs, 50.0 Mc/s at J156, via PL250, and 50/51 Mc/s at J154, by way of PL251 (in each case through 1-k Ω isolating resistance), are available only in the Type 1162-A, with the OMM-1 plugged in. Available voltage at these four ancillary jacks is about 0.1-volt across 1-k Ω . Except in early models, another output jack, J157, is mounted on the rear edge of the sandwich. This jack is connected to the REFERENCE line and makes available the 5- to 5.1-Mc output from the group of DI units "replaced" by the CAD.

BA-2.6 POWER-SUPPLY CONNECTIONS.

There are eight banana-plug connections through the bottom deck to the power supply. Four of these, PL305, PL306, PL307, and PL308, carry the input power line out of the power supply to the panel POWER switch and back again. Three others, PL301, PL302, and PL303, are separately filtered +18-Vdc outputs (see Section GC for details on the power supply).

The +18-volt #1 line (at PL302) feeds regulated voltage, through individual LC filters in the sandwich, to all the installed DI units and the CAD at plugs PL207-1 through PL207-7 and PL215. This output also supplies some of the AFS circuits via PL103 (see Section CB). The +18-volt #2 line is separately filtered and supplies the Picket-Fence section of the AFS by way of PL102. The third output, +18-volt #3 line, is used by the Output Amplifier. Available at PL303, it connects to AT418 on the Output Amplifier (Figure BA-8).

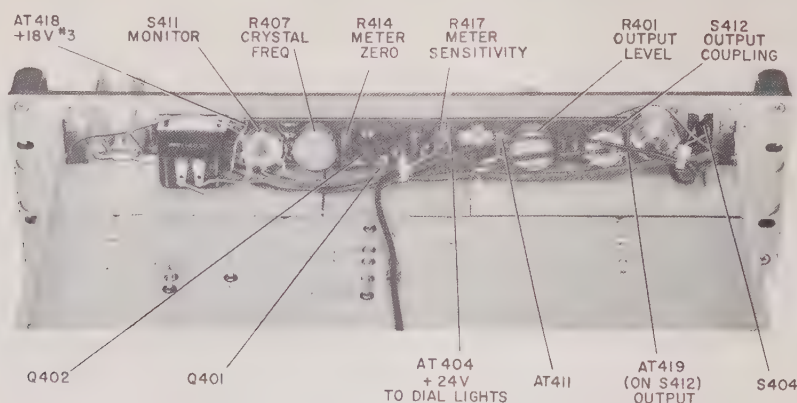


Figure BA-8. Behind-panel view (below-chassis deck) of Main Frame showing details of the Output Amplifier 1160-4040 (board in center).

The eighth connection to the power supply, PL304, brings out +24 volts unregulated to supply the dial lights. It is directly connected to an insulated tie-point, AT404, on the Output Amplifier board (Figure BA-8). For details on the dial-light circuits and switching operation, see Figure 4-8 and the Main Frame schematic diagram, Figure BA-9.

BA-2.7 OUTPUT AMPLIFIER.

The circuits of the Output Amplifier proper, which are a part of Output Amplifier assembly P/N 1160-4040, are shown on schematic diagram, Figure BA-10. (See also Figure BA-8.) The signal from the output mixer, f_o , connected to OUTPUT LEVEL control, R401, is amplified by Q401 and Q402 and connected to the output connector J405 by jumper wire from AT419.

Q401 and Q402 are used as a modified complementary Darlington pair. The voltage gain is a little greater than 2, due to the feedback division ratio of R411 and R413. The output, in the AC COUPLING position (selected by S412), is via blocking condenser C404 (paralleled by C403 to extend high-frequency performance). The output impedance of the amplifier is low (about 7 ohms) and the MONITOR meter reads output volts, from 0 to 2. The voltmeter rectifier CR401 and associated components are also mounted on this board. Since the MONITOR meter is normally zero-center, it is bucked to zero reading at zero output volts, by current through R415.

When S412 is in the DC position, the meter circuits are disconnected and the output is taken directly from the arm of potentiometer R401, the OUTPUT LEVEL control.

For mechanical convenience, MONITOR switch S411 is also mounted on the Output Amplifier board. This switch connects the meter to the chosen function—CAD CAL, OUTPUT VOLTS or LOCK TO EXT STD. For the first and third of these functions, leads are brought to the switch from the appropriate points in the sandwich. The "Rectified CAD Beat," at AT417, comes from terminal 4 of SO201, and the "Crystal Lock Monitor" enters at AT413 from PL110 at the

AFS station. The "Crystal Freq" line, from the AFS at PL111, also comes to S411 and R407 on the Output Amplifier board.

BA-2.8 AVAILABLE CHASSIS TEST POINTS.

Test points are accessible externally. Among these are the subminiature coaxial jacks, J150 through J157 on the rear edge of the sandwich, at which checks can be made of +18 V, 1 Mc/s, 5 Mc/s, 5/5.1 Mc/s (as set by the panel dials), 42 Mc/s, 50 Mc/s, 50/51 Mc/s, and the REFERENCE-line signal (5/5.1 Mc/s). (The 50-Mc and 50/51-Mc jacks are energized only in the Type 1162-A.) J157 is connected to the REFERENCE line and gives access to the output signal from the DI unit immediately above any actuated push-button. (When the button under the CAD is pushed, 5.0 Mc/s appears at J157.) The 5/5.1-Mc signal as it emerges from the train of DI units can also be measured at TP102, in the left-hand end pan (Figure 5-4). At adjacent TP103, the signal on the REFERENCE line (see Figure 4-6) is available behind R100.

If a dial light goes out, and there is a suspicion that the failure may be due to bulb burnout rather than to a DI malfunction, one can readily short out the error-sensing transistor, Q401-n. If the chassis is pulled forward out of its cabinet about one-half inch, the brass angle strips, carrying the pins on which the dial-light panel mounts, will be exposed. Each angle strip is connected to the low side of the lamp bulb; test of the bulb may be made by the momentary grounding of this strip (see Figure BA-4).

Of course, test points are also available at each sandwich-deck banana plug when the mating module is removed.

BA-2.9 DUPLICATE JACKS AT REAR.

Three BNC jacks are mounted on a rear bracket and connected in parallel with corresponding panel connectors. These rear jacks, J401A, J403A, and J405A, make available at the rear of the instrument the EXTERNAL CAD CONTROL, the BEAT output, and the main OUTPUT of the synthesizer.

SECTION BA-3

SERVICE AND MAINTENANCE

BA-3.1 CHASSIS MAINTENANCE.

Little or no maintenance should be required on the chassis. If mechanical trouble should develop in the rf switches, remove the three cover plates (see Figures BA-2 and BA-3). Remove the center plate first, then the side plates. If a switch has to be removed for repair or replacement, it may be necessary to reset the plunger of its pushbutton for proper switch throw. To adjust the plunger, pull off the nylon pushbutton cap. This exposes the coaxial plunger and lock nut (Figure BA-6). With the button actuated, loosen the lock nut with a suitable hollow tubular spanner (such as GR tool TO170) and, while holding the pushbutton body from turning, screw the plunger in or out as required for proper centering of the the switch blades on the contacts. Retighten the lock nut securely.

If for any reason it becomes necessary to inspect the interior of the sandwich, turn the instrument upside down, with the bottom plates of the sandwich deck uppermost, and proceed as follows:

CAUTION

Do not invert the Main Frame with the lower-deck plate removed. All banana plugs are held in place by the plate.

- a. Remove the switch cover plates.
- b. Disconnect the coaxial output cable at AT201 and AT202 (Figure BA-2).
- c. Remove the 23 #4-40 screws in the deck and the 6 #4-40 screws in the end pans.
- d. Dismount the angle bracket that supports the three BNC connectors at the rear of the sandwich.
- e. Then lift the lower-deck plate vertically, to clear the plugs, and slide it out to the rear.

When reinstalling the cover plate, make sure that all plugs (through both top and bottom decks) are

properly seated in their locating holes before finally tightening all screws.

BA-3.2 ELECTRICAL CHECKS - OUTPUT AMPLIFIER.

Table BA-1 gives typical voltage measurements at the specified points in the amplifier circuit. These checks must be made with the normal complement of modules installed in the chassis.

Additional test conditions, under which the voltages given in the table were obtained, call for the frequency dials to be set to 100 kc/s and for S412 (OUTPUT COUPLING) to be in its AC position. A reading of $+17.8 \pm 0.2$ Vdc should be obtained at AT418. With the Type 1806-A Electronic Voltmeter connected to read output volts, and S411 placed in its OUTPUT VOLTS position, the two trimpot controls adjacent to the bottom edge of the board should be adjusted, if necessary, to achieve correspondence between the indication on the front-panel meter and that on the Type 1806-A meter (see Figures BA-8 and BA-10).

With R401 in fully CCW position, both meters should read 0 volts. If the panel-meter reading is abnormal, adjust it with R414, the "Meter Zero" control.

Adjust R401 for 2.0 volts, rms, output. If the panel meter reading is at variance, adjust the indication with R417, the "Meter Sensitivity" control.

TABLE BA-1
DC VOLTAGES FOR A PROPERLY FUNCTIONING
OUTPUT AMPLIFIER (P/N 1160-4040)
(See Figure BA-10)

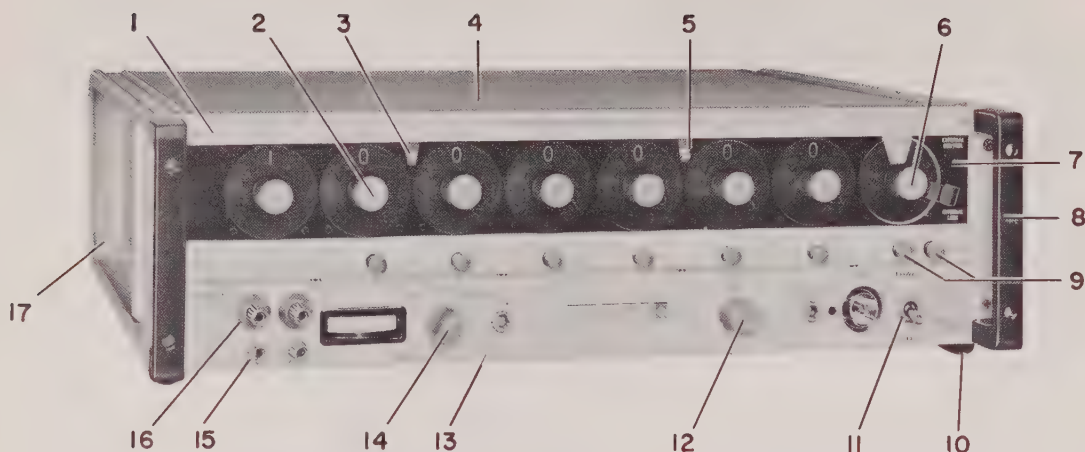
Stage	Collector	Base	Emitter
Q401	1.05	13.0	13.6
Q402	7.4	0.65	0

Notes: Taken with a Type 1806-A Electronic Voltmeter.
Tolerance $\pm 10\%$.

TABLES OF INTERCONNECTIONS

<u>Top Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>	<u>Top Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>
PL201	J101	Output Mixer OM-1	PL210-8	J401	
PL202	J102	(See Section FA —	PL213	J101	Cont. Adj. Decade CAD-1
PL203	J202	for Type 1161)	PL214	J403	(See Section EA)
PL204	J201	or	PL215	J402	
PL205	J102A	Output Multiplier-Mixer	PL216	J404	
PL206	J101A	OMM-1 (See Section FB	PL217	J102	
		— for Type 1162)			
PL250	J103A	For OMM-1 only			
PL251	J103				
PL207-N (1-7)	J301	Digit Insertion Unit DI	SO201	PL101	Calibrating Mixer CM-1
PL208-N	J302	(7 Installed)	(terminals	(terminals	(See Section EA)
PL209-N	J303	(See Section DI)	1-6)	1-6)	
PL210-N	J306				
PL211-N	J304				
PL212-N	J305				

<u>Bottom Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>	<u>Bottom Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>
PL101	J201	Ancillary Frequency	PL301	J506	Power Supply PS-3
PL102	J202	Source AFS	PL302	J507	(See Section GC)
PL103	J105	(See Section CB)	PL303	J508	
PL104	J204		PL304	J505	
PL105	J205		PL305	J501	
PL106	J203		PL306	J503	
PL107	J106		PL307	J502	
PL108	J104		PL308	J504	
PL109	J301				
PL110	J103				
PL111	J101				



MECHANICAL PARTS LIST

Quantity	Ref. No.	Name	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
1	1	Dial strip (1161)	Dial strip	1161-8000	24655	1161-8000	
1	1	Dial strip (1162)	Dial strip	1162-8000	24655	1162-8000	
2	7	Dial and Knob asm.	Dial and Knob asm.	1160-1320	24655	1160-1320	
7	7	Dial	Dial	1160-7320	24655	1160-7320	
7	7	Knob including retainer 5220-5402	Knob including retainer 5220-5402	5520-5232	24655	5520-5232	
3	1	Comma	Comma	1160-8762	24655	1160-8762	
4	1	Cabinet	Cabinet	1160-1474	24655	1160-1474	
5	1	Decimal point	Decimal point	1160-8761	24655	1160-8761	
6	1	Dial and Knob asm.	Dial and Knob asm., CAD	1160-1310	24655	1160-1310	
1	1	Dial	Dial	1160-7310	24655	1160-7310	
1	1	Knob including retainer 5220-5402	Knob including retainer 5220-5402	5520-5232	24655	5520-5232	
7	1	Mode switch lever	Mode switch lever	1160-2160	24655	1160-2160	
8	2	Handle	Handle	5360-2012	24655	5360-2012	
9	8	Switch	Push button switch, CAD OFF and DIGIT DISABLE	1160-2360	24655	1160-2360	
10	4	Foot	Foot, soft, black neoprene	5260-0170	24655	5260-0170	
11	1	Nut	Dress nut, 15/32-32, 7/16	5800-0800	24655	5800-0800	5310-344-3634
12	1	Knob asm.	Knob, OUTPUT LEVEL, including retainer 5220-5402	5520-5221	24655	5520-5221	
13	2	Nut	Dress nut, 3/8-32, 7/16	5800-0799	24655	5800-0799	5310-991-7185
14	1	Knob asm.	Knob, OUTPUT VOLTS, including retainer 5220-5402	5500-5221	24655	5500-5221	
15	2	Spacer	Spacer	7800-0600	24655	7800-0600	
16	2	Insulator	Insulator	0938-7130	24655	0938-7130	
17	2	End frame asm.	End frame asm.	5310-9632	24655	5310-9632	
—	1	Lamp holder asm. (refer to Figure BA-5)	Lamp holder, CAD, includes lamp	1160-2081	24655	1160-2081	
—	7	Lamp holder asm. (refer to Figure BA-5)	Lamp holder, includes lamp	1160-2080	24655	1160-2080	
rear	2	Dress nut	Dress nut	1160-6570	24655	1160-6570	
rear	2	Clamp bracket	Clamp bracket	1160-8023	24655	1160-8023	
rear	1	Plug support bar	Plug support bar	1160-8024	24655	1160-8024	

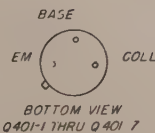
ELECTRICAL PARTS LIST

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C101	Ceramic, 0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-974-5699
C102	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C201	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C202	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C203-1	Ceramic, 2.2 μ F $\pm$ 20% 25 V	4400-2080	24655	4400-2080	
C203-2	Ceramic, 2.2 μ F $\pm$ 20% 25 V	4400-2080	24655	4400-2080	
C203-3	Ceramic, 2.2 μ F $\pm$ 20% 25 V	4400-2080	24655	4400-2080	
C203-4	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C203-5	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C203-6	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C203-7	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C203-8	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C301	Ceramic, 0.02 μ F +80-20% 50 V	4402-3200	01121	36-203W, 0.02 μ F +80-20%	5910-974-5698
C302	Ceramic, 0.02 μ F +80-20% 50 V	4402-3200	01121	36-203W, 0.02 μ F +80-20%	5910-974-5698
C208	Ceramic, 0.0022 μ F +80-20% 500 V	4404-2229	72982	831, 0.0022 μ F +80-20%	
C209	Ceramic, 0.0022 μ F +80-20% 500 V	4404-2229	72982	831, 0.0022 μ F +80-20%	
INDUCTORS					
L101	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L102	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L201	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L202	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L203-1	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
through L203-8	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L204	Choke, iron core, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
JACKS					
J150					
through J157	Coaxial, miniature, bulkhead jack, 10-32 thread	4260-1288	02660	5116058350	
J401	Binding post, asm.	0938-3000	24655	0938-3000	
J402	Binding post assembly	0938-3000	24655	0938-3000	
J403	Binding post assembly	0938-3000	24655	0938-3000	
J404	Binding post assembly	0938-3000	24655	0938-3000	
J405	GR874, coaxial, panel	0874-4504	24655	0874-4504	
J406	Banana, panel mount	0874-6690	24655	0874-6690	
J401A	Coaxial, type BNC, bulkhead jack	4230-2300	81349	UG-10941U	
J403A	Coaxial, type BNC, bulkhead jack	4230-2300	81349	UG-10941U	
J405A	Coaxial, type BNC, bulkhead jack	4230-2300	81349	UG-10941U	
PLUGS					
PL101					
through PL111	Banana, with special mount	1160-2120	24655	1160-2120	
PL201					
through PL206	Banana, with special mount	1160-2120	24655	1160-2120	
PL207-1					
through PL207-7	Banana, with special mount	1160-2120	24655	1160-2120	
PL208-1					
through PL208-7	Banana, with special mount	1160-2120	24655	1160-2120	
PL209-1					
through PL209-7	Banana, with special mount	1160-2120	24655	1160-2120	
PL210-1					
through PL210-8	Banana, with special mount	1160-2120	24655	1160-2120	
PL211-1	Banana, part of switch assembly	1160-2741	24655	1160-2741	
PL211-2					
through PL211-7	Banana, part of switch assembly	1160-2740	24655	1160-2740	
PL212-1					
through PL212-7	Banana, part of switch assembly	1160-2740	24655	1160-2740	
PL213	Banana, part of switch assembly	1160-2740	24655	1160-2740	
PL214					
through PL217	Banana, with special mount	1160-2120	24655	1160-2120	
PL250	Banana, with special mount	1160-2120	24655	1160-2120	
PL251	Banana, with special mount	1160-2120	24655	1160-2120	
PL301					
through PL308	Banana, with special mount	1160-2120	24655	1160-2120	

ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
RESISTORS					
R100	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5% 1/4 W	5905-681-6462
R101	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5% 1/4 W	
R102	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5% 1/4 W	
R103	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5% 1/4 W	
R104	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5% 1/4 W	
R105	Composition, 470 Ω $\pm$ 5% 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm$ 5%	
R106	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	
R107	Composition, 180 Ω $\pm$ 5% 1/4 W	6099-1185	75042	BTS, 180 Ω $\pm$ 5%	5905-279-5476
R108	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R401-1 through R401-7	Composition, 1.5 k Ω $\pm$ 5% 1/2 W, part of DI dial assembly	1160-2100	24655	1160-2100	
R402	Composition, 82 Ω $\pm$ 5%, 1/2 W, part of CAD dial assembly	1160-2090	24655	1160-2090	
SWITCHES					
S201	Special rf assembly	1160-2741	24655	1160-2741	
S202-1 through S202-7	Special rf assembly	1160-2740	24655	1160-2740	
S401-1 through S401-7	Switch, part of DI dial assembly	1160-2100	24655	1160-2100	
S402	Switch, part of CAD dial assembly	1160-2090	24655	1160-2090	
S403	Toggle, DPST	7910-1300	04009	83053-SA	5930-909-3510
TRANSISTORS					
Q401-1 through Q401-7	Type 2N1304, part of DI dial assembly	8210-1304	01295	2N1304	5961-892-0800
CIRCUIT-BOARD ASSEMBLIES					
—	Lamp control (DI Station)	1160-2100	24655	1160-2100	
—	Lamp control (CAD Station)	1160-2090	24655	1160-2090	
—	Assembly, output amplifier, etched-circuit board	1160-4040	24655	1160-4040	
MISCELLANEOUS					
—	Knob, DI control	1160-1300	24655	1160-1300	
—	Knob, CAD control	1160-1310	24655	1160-1310	
M401	Edgewise, panel, 100-0-100 μ A $\pm$ 3%, 461 Ω $\pm$ 20%	5730-1382	81030	Meds 1382	
P401-1 through P401-8	Lamp	5600-1060	24655	5600-1060	
SO201	Connector, multiple	4230-2706	95354	CD606SF	
—	Knob	5520-5221	24655	5520-5221	
—	Knob	5520-5221	24655	5520-5221	
—	Knob	5520-5221	24655	5500-5221	
—	Handle	5360-0593	24655	5360-0593	

NOTE UNLESS SPECIFIED	
1 POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE	5 RESISTANCE IN OHMS K 1000 OHMS M MEGOHM
2 CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK	6 CAPACITANCE VALUES ONE AND OVER IN PICOFARADS LESS THAN ONE IN MICROFARADS
3 REFER TO SERVICE NOTES IN INSTR UTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM	7 $\bigcirc$ KNOB CONTROL
4 RESISTORS 1/4 WATT	8 $\bigcirc$ SCREWDRIVER CONTROL
	9 AT ANCHOR TERMINAL
	10 TP TEST POINT



*NOTE
S404 EXISTS ONLY WHEN CAD-1
MODULE IS IN PLACE, AND IS
MECHANICALLY GANGED WITH
S101 OF THE CAD-1 MODULE

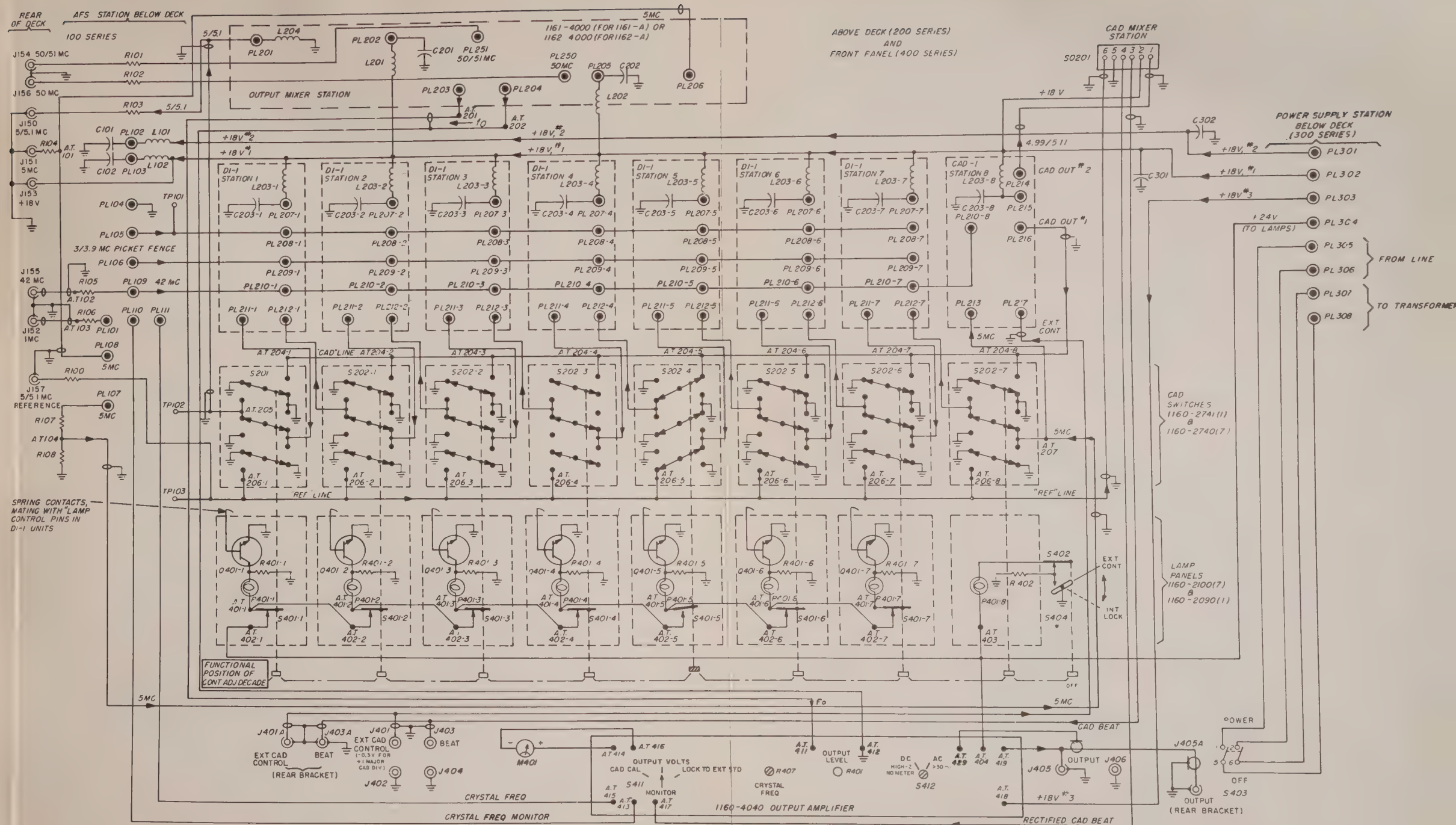
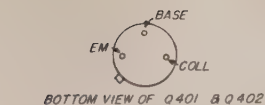


Figure BA-9.
Over-all schematic diagram for Main Frame Chassis 1160-4060.

ELECTRICAL PARTS LIST OUTPUT AMPLIFIER

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C401	Ceramic, .22 μ F $\pm$ 20% 25 V	4400-2052	80183	5C13, .22 μ F $\pm$ 20%	5910-974-5694
C402	Electrolytic, 180 μ F $\pm$ 20% 6 V	4450-5617	56289	150D187X0006R2	
C403	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C404	Special, 220 μ F $\pm$ 20% 10 V	1160-0410	24655	1160-0410	
C405	Ceramic, 470 pF $\pm$ 10% 500 V	4404-1478	72982	831, 470 pF $\pm$ 10%	
C406	Electrolytic, 6.8 μ F $\pm$ 20% 6 V	4450-4800	56289	150D685X0010A2	
C407	Electrolytic, 15 μ F $\pm$ 20% 20 V	4450-5200	56289	150D156X0020B2	
C408	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C409	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
RESISTORS					
R401	Potentiometer, composition, 10 k Ω $\pm$ 10% 6047-3109	01121	JAIN132P103UZ		
R402	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	
R403	Composition, 12 k Ω $\pm$ 5% 1/4 W	6099-3125	75042	BTS, 12 k Ω $\pm$ 5%	
R404	Composition, 15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R405	Composition, 6.2 k Ω $\pm$ 5% 1/4 W	6099-2625	75042	BTS, 6.2 k Ω $\pm$ 5%	
R406	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R407	Potentiometer, composition, 10 k Ω $\pm$ 10% 6020-0400	01121	JA, 10 k Ω $\pm$ 10%		5905-829-3323
R408	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm$ 5%	
R409	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240
R410	Composition, 680 Ω $\pm$ 5% 1/4 W	6099-1680	75042	BTS, 680 Ω $\pm$ 5%	
R411	Wire-wound, 68 Ω $\pm$ 5% 2 W	6760-0685	75042	BWH, 68 Ω $\pm$ 5%	5905-681-9969
R412	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	
R413	Wire-wound, 43 Ω $\pm$ 5% 2 W	6760-0435	75042	BWH, 43 Ω $\pm$ 5%	
R414	Potentiometer, wire-wound, 20 k Ω $\pm$ 10% 6051-3209	80294	3067P-1-203		
R415	Composition, 100 k Ω $\pm$ 5% 1/4 W	6099-4105	75042	BTS, 100 k Ω $\pm$ 5%	5905-686-3129
R416	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R417	Potentiometer, wire-wound, 5 k Ω $\pm$ 10% 6051-2509	80294	3067P-1-502		
MISCELLANEOUS					
CR401	Diode, type 1N34 (s)	6082-1003	90139	1N34A(S)	5961-170-4430
S411	Switch, rotary wafer	7890-3840	76854	241159-A1	
S412	Switch, rotary wafer	7890-3850	76854	241160-A1	
Q401	Transistor, type 2N3250	8210-1089	80211	2N3250	5961-945-4108
Q402	Transistor, type 2N2218	8210-1028	81349	2N2218	5960-059-4464



BOTTOM VIEW OF Q401 & Q402

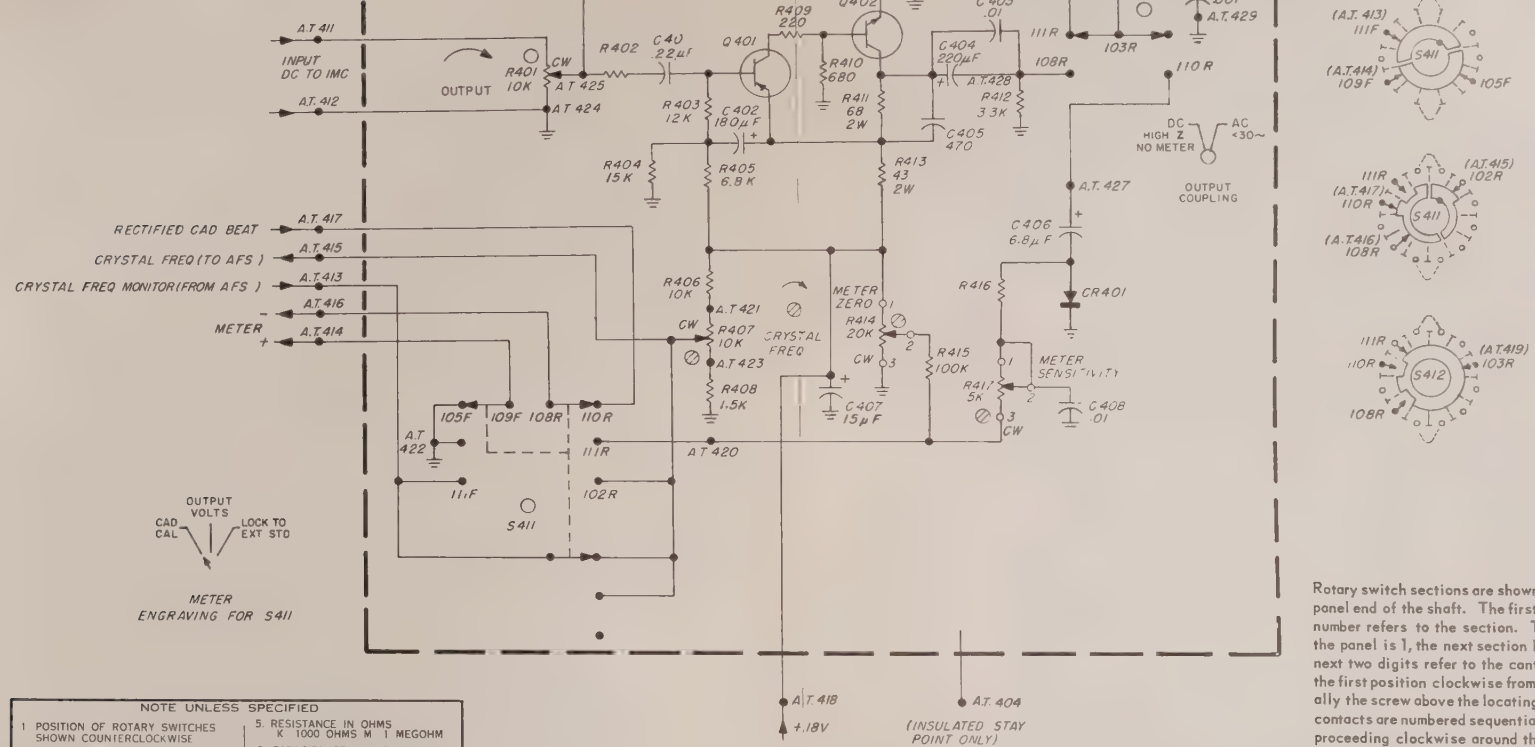


Figure BA-10.
Schematic diagram for Output Amplifier 1160-4040.

NOTE UNLESS SPECIFIED	
1 POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE	5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
2 CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK	6 CAPACITANCE VALUES ONE AND OVER IN PICO FARADS LESS THAN ONE IN MICRO FARADS
3 REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM	7 KNOB CONTROL
4 RESISTORS 1/4 WATT	8 SCREWDRIVER CONTROL
	9 AT ANCHOR TERMINAL
	10 TP TEST POINT

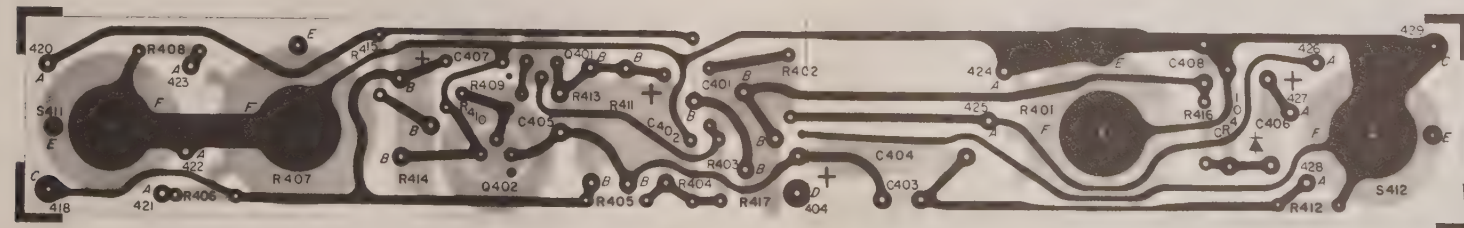


Figure BA-11.
Etched-circuit assembly (P/N 1160-4040).

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

—TABLES OF INTERCONNECTIONS

<u>Top Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>	<u>Top Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>
PL201	J101	Output Multiplier Mixer OMM-2 (Section FC)	PL210-8	J401	Cont. Adj. Decade CAD-1 (Section EA)
PL202	J102		PL213	J101	
PL203	J103		PL214	J403	
PL204	J201		PL215	J402	
PL205	J202		PL216	J404	
PL206	J203		PL217	J102	
PL207	J204				
PL207-N (1-7)	J301	Digit Insertion Unit DI (7 Installed) (Section DI)	PL241	J202	Digit Insertion Unit RDI-4 (Section DD)
PL208-N	J302		PL242	J203	
PL209-N	J303		PL207-1	J201	
PL210-N	J306				
PL211-N	J304		SO201	PL101	Calibrating Mixer CM-1 (Section EA)
PL212-N	J305		(Terminals 1-6)		

<u>Bottom Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>	<u>Bottom Deck</u>	<u>Mating Connector</u>	<u>Mating Unit</u>
PL101	J201	Ancillary Frequency Source	PL301	J506	Power Supply PS-3 (Section GC)
PL102	J202		PL302	J507	
PL103	J105		PL303	J508	
PL104	J204		PL304	J505	
PL105	J205		PL305	J501	
PL106	J203		PL306	J503	
PL107	J106		PL307	J502	
PL108	J104		PL308	J504	
PL109	J301				
PL110	J103				
PL111	J101				

NOTE: The parts list appears on page BB-6.

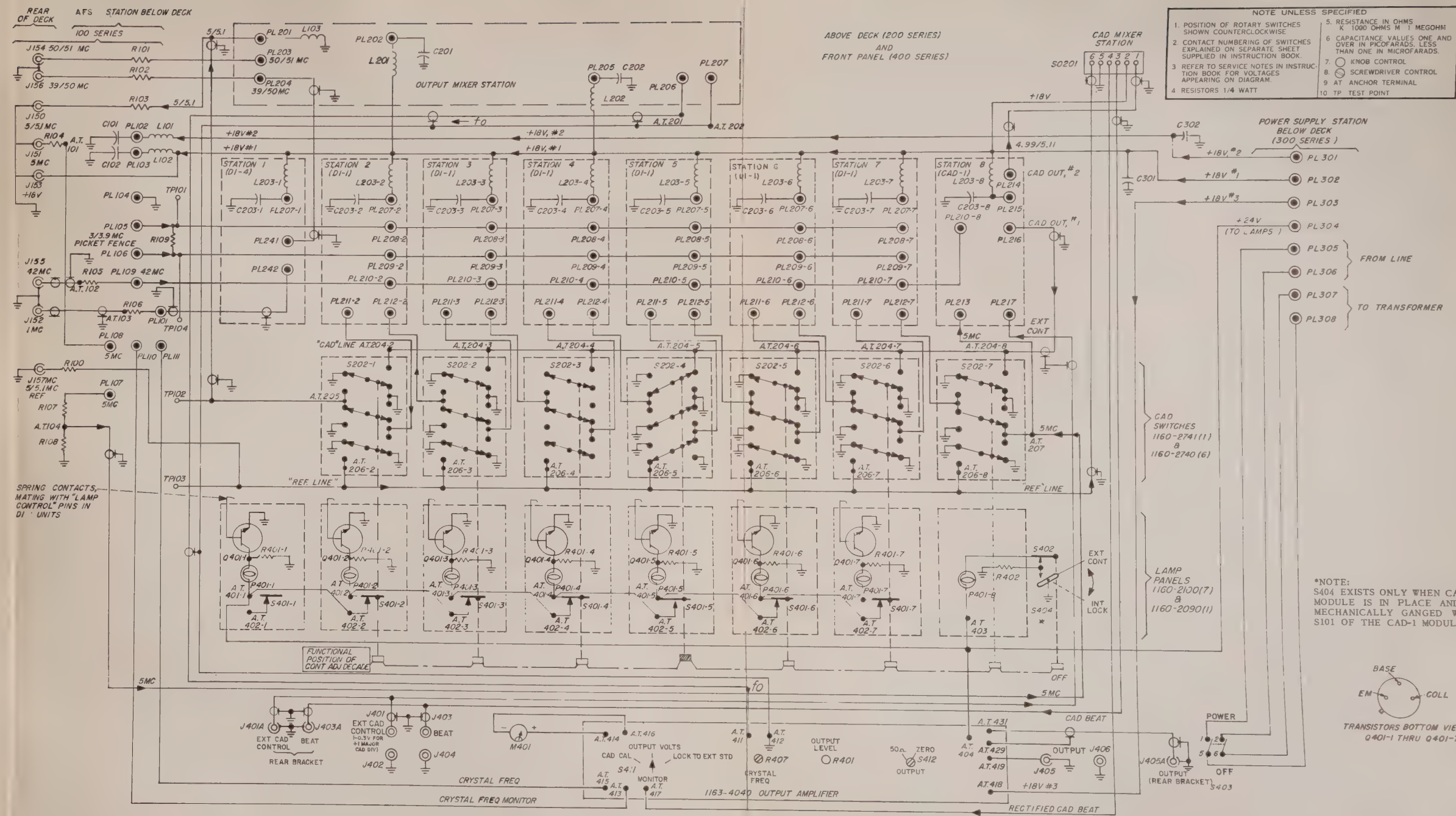


Figure BB-3.
Over-all schematic diagram for Main Frame Chassis 1163-4060.

ELECTRICAL PARTS LIST

OUTPUT AMPLIFIER

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C401	Electrolytic, 33 μ F $\pm 20\%$ 10 V	4450-5400	56289	150D336X0010B1	5910-823-1623
C402	Electrolytic, 47 μ F $\pm 20\%$ 6 V	4450-5500	56289	150D476X0006B2	5910-752-4185
C403	Electrolytic, 15 μ F $\pm 20\%$ 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C404	Electrolytic, 220 μ F $\pm 20\%$ 15 V	1160-0410	24655	1160-0410	
C405	Electrolytic, 15 μ F $\pm 20\%$ 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C406	Ceramic, 0.01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
RESISTORS					
R401	Potentiometer, composition, 250 Ω $\pm 10\%$	6047-1259	01121	JA, 250 Ω $\pm 10\%$	
R402	Composition, 47 Ω $\pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm 5\%$	
R403	Potentiometer, wire-wound, 20 k Ω $\pm 10\%$	6051-3209	80294	3067P-1-203	
R404	Composition, 330 Ω $\pm 5\%$ 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm 5\%$	5905-686-3369
R405	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$	5905-681-6462
R406	Composition, 10 k Ω $\pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm 5\%$	5905-683-2238
R407	Potentiometer, composition, 10 k Ω $\pm 10\%$	6020-0400	01121	JA, 10 k Ω $\pm 10\%$	5905-829-3323
R408	Composition, 1.5 k Ω $\pm 5\%$ 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm 5\%$	
R409	Composition, 100 Ω $\pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm 5\%$	
R410	Composition, 220 Ω $\pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm 5\%$	5905-683-2240
R411	Composition, 820 Ω $\pm 5\%$ 1/4 W	6099-1825	75042	BTS, 820 Ω $\pm 5\%$	
R412	Composition, 47 Ω $\pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm 5\%$	
R413	Composition, 47 Ω $\pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm 5\%$	
R414	Potentiometer, wire-wound, 20 k Ω $\pm 10\%$	6051-3209	02660	2600PC, 20 k Ω $\pm 10\%$	
R415	Composition, 100 k Ω $\pm 5\%$ 1/4 W	6099-4105	75042	BTS, 100 k Ω $\pm 5\%$	5905-686-3129
R416	Composition, 10 k Ω $\pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm 5\%$	5905-683-2238
R417	Potentiometer, wire-wound, 20 k Ω $\pm 10\%$	6051-2509	02660	2600PC, 20 k Ω $\pm 10\%$	
R418	Composition, 10 Ω $\pm 5\%$ 1/4 W	6099-0105	75042	BTS, 10 Ω $\pm 5\%$	5905-809-8596
R419	Composition, 10 Ω $\pm 5\%$ 1/4 W	6099-0105	75042	BTS, 10 Ω $\pm 5\%$	5905-809-8596
R420	Composition, 51 Ω $\pm 5\%$ 1/4 W	6099-0515	75042	BTS, 51 Ω $\pm 5\%$	
R421	Composition, 3.3 k Ω $\pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm 5\%$	5905-681-9969
R422	Composition, 51 Ω $\pm 5\%$ 1/4 W	6099-0515	75042	BTS, 51 Ω $\pm 5\%$	
TRANSISTORS					
Q401	Type 2N918	8210-1066	07263	2N3563	
Q402	Type 2N918	8210-1066	07263	2N3563	
Q403	Type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q404	Type 2N2904	8210-1074	93916	2N2904	
MISCELLANEOUS					
CR401	Diode, semiconductor, type 1N994	6082-1017	24446	1N994	
L401	Inductor, choke, iron core, 2.7 μ H $\pm 10\%$	4300-1300	99800	1537-22, 2.7 μ H $\pm 10\%$	
S411	Switch, rotary, wafer	7890-3840	76854	241159-A1	
S412	Switch, rotary, wafer	7890-3850	76854	241160-A1	
Z401	Rigid Cable	1163-0206	24655	1163-0206	

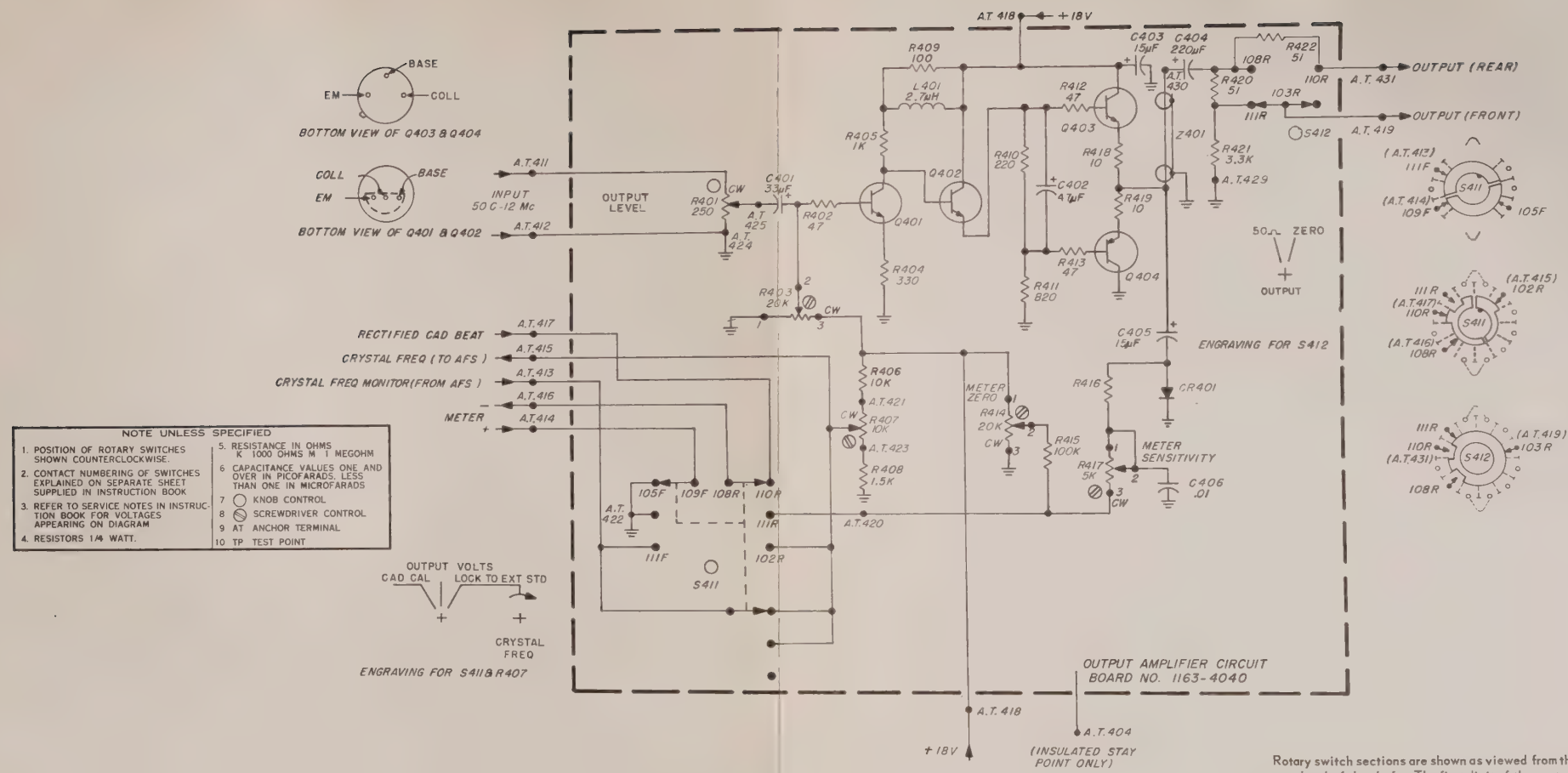


Figure BB-5.
Schematic diagram for Output Amplifier 1163-4040.

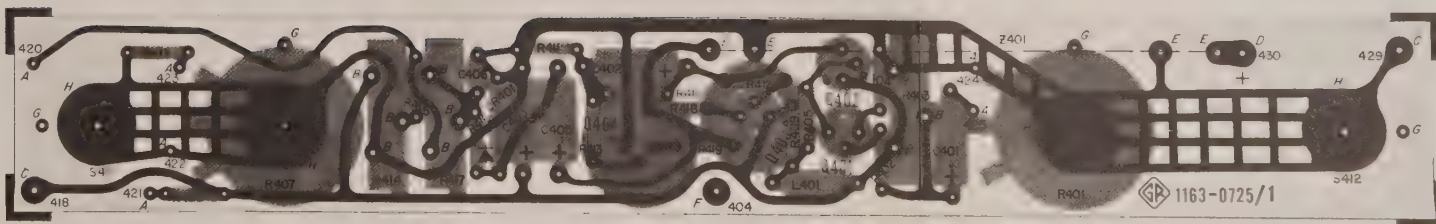


Figure BB-4.
Etched Circuit assembly (P/N 1163-4040) for Output Amplifier.

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

SERVICE INSTRUCTIONS

section BB

MAIN FRAME & OUTPUT AMPLIFIER

P/N 1163-4060
Chassis for Type 1163 Synthesizers
(Including Output Amplifier P/N 1163-4040)

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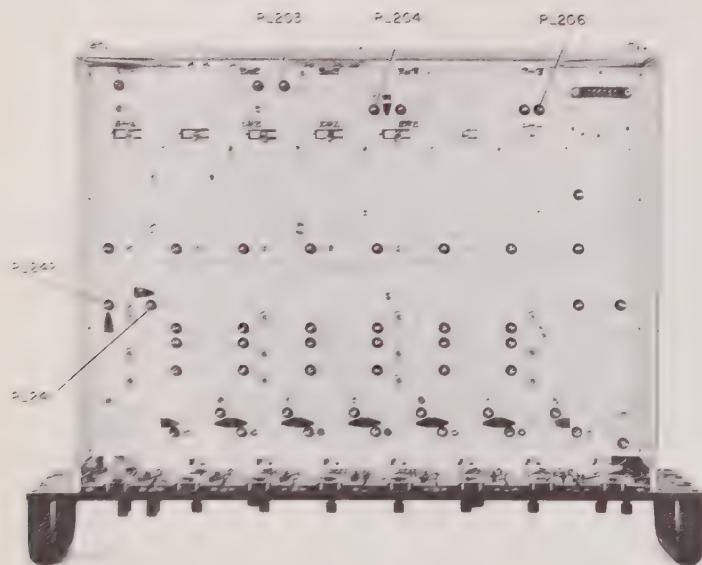


Figure BB-1.
Synthesizer Main Frame - top
deck of chassis. Callouts in-
dicate important module inter-
connection points.

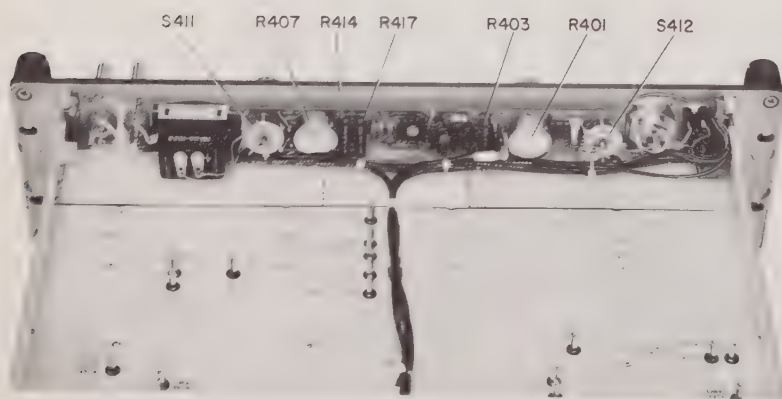


Figure BB-2.
Synthesizer Main Frame -
Output Amplifier detail
on chassis lower deck.

CAUTION

Do not connect dc potentials to the synthesizer output connector, or damage to the Output Amplifier may result.

SECTION**BB-1.1 GENERAL.**

Inasmuch as Main Frame 1163-4060 is nearly identical with the basic Main Frame (1160-4060), described in detail in Section BA of this manual, the material of Section BA will not be repeated here. This section will cover only the differences between the two.

BB-1.2 PURPOSE.

The Main Frame (1163-4060) is the foundation for the Type 1163 synthesizer and provides mounting facilities for, and interconnections between, the plug-in modules. It also incorporates the final stages of the Output Amplifier (an output preamplifier is included in the Output Multiplier-Mixer, OMM-2).

A completely filled Type 1163-A Main Frame contains one less DI unit than is the case in a corresponding Type 1161-A or 1162-A model. The missing DI unit, at the left-hand digit station, is replaced by an RDI-4 unit (described in Section DD). The space allotted to the OM-1 or OMM-1 module in chassis 1160-4060 is occupied by the OMM-2 module in the Type 1163-A chassis. The RDI-4 unit generates megacycle steps in the synthesizer output by supplying selectable frequencies from 50 to 39 Mc/s to the low-level mixer in the OMM-2. Since the RDI-4 and the OMM-2 require different inputs, outputs, and interconnections than are available in the Types 1161/1162 Main Frame, the Type 1163-4060 Main Frame chassis differs primarily in these regions. Mounting arrangements and interconnections elsewhere are identical, except for minor differences in the Output Amplifier.

BB-1.3 DIFFERENCES FROM MAIN FRAME 1160-4060.

The major differences can easily be seen by comparison of schematic diagrams, Figure BA-9 in Section BA and Figure BB-3 in this section.

BB-1.3.1 SANDWICH DECK
(Figures BB-1 and BB-2).

The deck and internal wiring are identical with that of 1160-4060, except where the RDI-4 unit and the OMM-2 mount. At the RDI-4 location (Station 1), there are no input banana plugs for 42 Mc/s or the Picket Fence; instead, plug PL242 supplies a 1-Mc input. PL242 is connected within the sandwich to the 1.0-Mc line where it emerges from the AFS unit at PL101. The RDI-4 output is taken by PL241 and carried by a coaxial line within the sandwich to PL204 at the Output Mixer station.

At the Output Mixer station, the 5/5.1 input via PL201 is the same as in the other chassis, except that the source of signal is the last pushbutton-controlled rf switch (S202-1 under the last DI unit at digit station 2). The output from the OMM-2 station is at PL206, near the right-hand end of the station. PL203 (50/51 Mc/s output to J154) is at the same location as the corresponding PL251 in chassis 1160-4060; PL204 brings out 50 to 39 Mc/s to a rear-apron jack, J156. (In chassis 1160-4060, J156 receives 50 Mc/s only, from PL250 of that chassis.)



In the sandwich deck, the rf switch under digit station 1 and its associated pushbutton are omitted, as previously noted.

BB-1.3.2 PUSHBUTTON AND DIAL LIGHTS.

The pushbutton and dial-light circuitry is exactly the same as in chassis 1160-4060 (Section BA) except that the left-hand pushbutton is omitted. The dial light at station 1, however, is still wired to give warning of phase-lock failure in the RDI-4 unit (refer to Section DD and the schematic of the Type 1163-A chassis, Figure BB-3, for details).

BB-1.3.3 OUTPUT AMPLIFIER 1163-4040 (Figures BB-4 and BB-5).

The Output Amplifier assembly is mounted behind the lower center section of the front panel. Board size and mounting arrangements are the same as for the output amplifier of the 1160-4060 Main Frame. MONITOR switch, S411, and its circuits are identical to corresponding components on Output Amplifier 1160-4060, as are the voltmeter circuits (refer to Section BA, paragraph BA-2.6).

The Output Amplifier itself is somewhat different. In Main Frame 1163-4060, Q401 is an amplifier, with a voltage gain of about 2, for the output signal from the preamplifier in the OMM-2 (refer to section FC). L401 and R409 are compensating elements for the high-frequency end of the band. Q402 is an emitter-follower driver for the push-pull class-A emitter-follower output stages, Q403 and Q404.

In the 1163-4040 amplifier, the screwdriver-operated output switch S412 inserts or shorts out 51-ohm resistors in the lines to the front and rear output connectors of the 1163-4060 chassis (J405 and J405A). The output voltage, metered at the driving side of these resistors, is taken from the low output impedance emitter-follower output stage.

R403 is a bias-setting potentiometer that can be adjusted to produce ≈ 9.5 Vdc at the junction of R418 and R419, to minimize harmonic distortion in the amplifier.

BB-1.3.4 CHASSIS TEST POINTS.

The available chassis test points on the 1163-4060 Main Frame are the same as those on the 1160-4060 (Section BA) except as follows:

1. Both sides of the Picket-Fence line are available, at TP101 and TP104, in the left end pan, instead of only one side as in 1160-4060.
2. J156 provides (through a 1 k Ω isolating resistor) the output frequency of the RDI-4 unit - 50 to 39 Mc/s as the dial is changed from 0 to 11. In the 1160-4060 a single frequency, at 50 Mc/s, appears at the corresponding connection.

BB-1.3.5 MAINTENANCE.

Maintenance procedures for the 1163-4060 chassis are no different from those for the 1160-4060 (Section BA).

BB-2.1 ELECTRICAL CHECKS, OUTPUT AMPLIFIER.

Table BB-1 gives typical voltage measurements at the specified points in the amplifier circuit. These checks must be made with the normal complement of modules installed in the chassis.

TABLE BB-1

DC VOLTAGES FOR A PROPERLY FUNCTIONING
OUTPUT AMPLIFIER (P/N 1163-4060)
(See Figure BB-5)

<i>Stage</i>	<i>Collector</i>	<i>Base</i>	<i>Emitter</i>
Q401	11.4	2.60	2.00
Q402	17.9	11.40	10.80
Q403	17.9	10.80	10.20
Q404	0	8.60	9.20

Notes: Unit operating with input connected (installed in chassis) output level fully CCW. Voltages measured with Type 1806-A direct (DC). These are typical readings; variations of $\pm 10\%$ are to be expected.

ABOVE DECK (200 SERIES)
AND
FRONT PANEL (400 SERIES)

CAD MIXER
STATION

50201

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT
5. RESISTANCE IN OHMS
K 1000 OHMS M 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICO FARADS. LESS THAN ONE IN MICROFARADS
7. KNOB CONTROL
8. SCREWDRIVER CONTROL
9. AT ANCHOR TERMINAL
10. TP TEST POINT

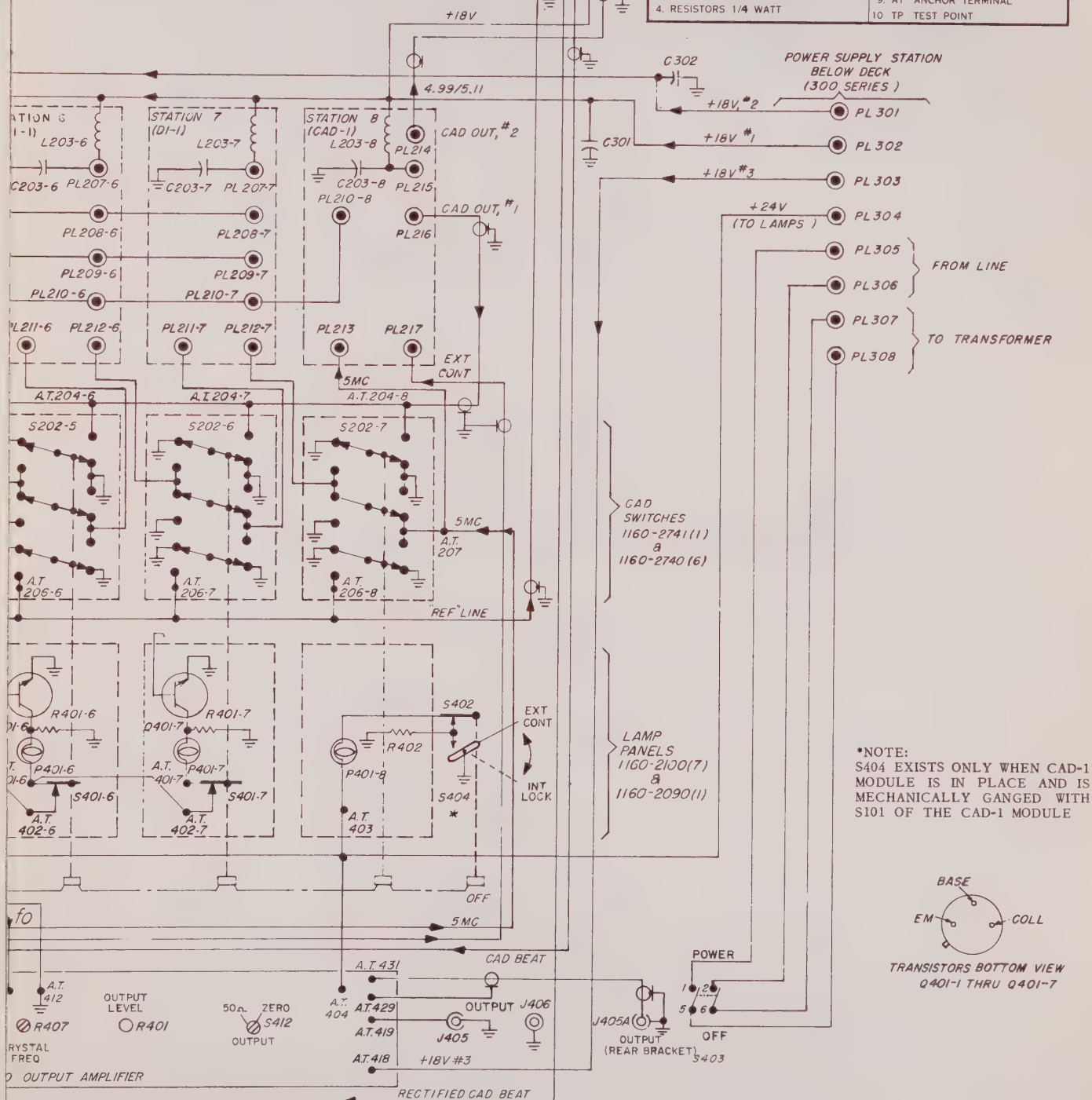


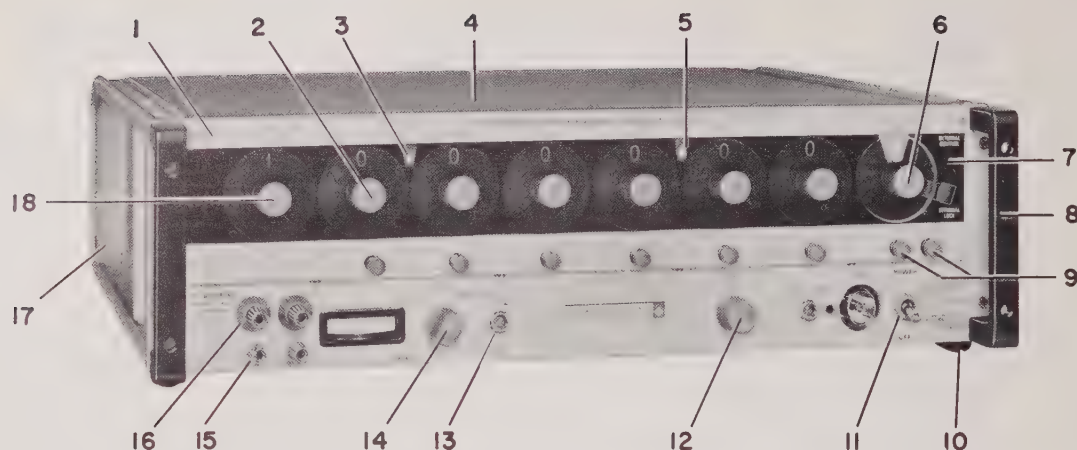
Figure BB-3.
Over-all schematic diagram for Main Frame Chassis 1163-4060.

ELECTRICAL PARTS LIST

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C101	Ceramic, 0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-974-5699
C102	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C201	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C202	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C203-1	Ceramic, 2.2 μ F $\pm$ 20% 25 V	4400-2080	24655	4400-2080	
C203-2	Ceramic, 2.2 μ F $\pm$ 20% 25 V	4400-2080	24655	4400-2080	
C203-3	Ceramic, 2.2 μ F $\pm$ 20% 25 V	4400-2080	24655	4400-2080	
C203-4	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C203-5	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C203-6	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C203-7	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C203-8	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C301	Ceramic, 0.02 μ F +80-20%	4402-3200	01121	36-203W, 0.02 μ F +80-20%	5910-974-5698
C302	Ceramic, 0.02 μ F +80-20%	4402-3200	01121	36-203W, 0.02 μ F +80-20%	5910-974-5698
C208	Ceramic, 0.0022 μ F +80-20% 500 V	4404-2229	72982	831, 0.0022 μ F +80-20%	
C209	Ceramic, 0.0022 μ F +80-20% 500 V	4404-2229	72982	831, 0.0022 μ F +80-20%	
INDUCTORS					
L101	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L102	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L103	Choke, iron core, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L201	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L202	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
L203-1 through L203-8	Choke, iron core, 22 μ H $\pm$ 10%	4300-6600	99800	2890, 22 μ H $\pm$ 10%	
JACKS					
J150 through J157	Coaxial, miniature, bulkhead jack, 10-32 thread	4260-1288	02660	5116058350	
J401	Binding post, insulated	0938-3000	24655	0938-3000	
J402	Binding post	0938-3000	24655	0938-3000	
J403	Binding post, insulated	0938-3000	24655	0938-3000	
J404	Binding post	0938-3000	24655	0938-3000	
J405	GR874, coaxial, panel	0874-4504	24655	0874-4504	
J406	Banana, panel mount	0874-6690	24655	0874-6690	
J401A	Coaxial, type BNC, bulkhead jack	4230-2300	81349	UG-10941U	
J403A	Coaxial, type BNC, bulkhead jack	4230-2300	81349	UG-10941U	
J405A	Coaxial, type BNC, bulkhead jack	4230-2300	81349	UG-10941U	
PLUGS					
PL101 through PL111	Banana, with special mount	1160-2120	24655	1160-2120	
PL201 through PL207	Banana, with special mount	1160-2120	24655	1160-2120	
PL207-1 through PL207-7	Banana, with special mount Part of 1160-2430	1160-2120	24655	1160-2120	
PL208-2 through PL208-7	Banana, with special mount	1160-2120	24655	1160-2120	
PL209-2 through PL209-7	Banana, with special mount	1160-2120	24655	1160-2120	
PL210-2 through PL210-8	Banana, with special mount	1160-2120	24655	1160-2120	
PL211-2 Part of 1160-2741	Banana, part of switch assembly	1160-2741	24655	1160-2741	
PL211-3 through PL211-7	Banana, part of switch assembly Part of 1160-2740	1160-2740	24655	1160-2740	
PL212-2 through PL212-7	Banana, part of switch assembly Part of 1160-2740	1160-2740	24655	1160-2740	
PL213 Part of 1160-2740	Banana, part of switch assembly	1160-2740	24655	1160-2740	
PL214 through PL217	Banana, with special mount	1160-2120	24655	1160-2120	
PL241 Part of 1160-2740	Banana, with special mount	1160-2120	24655	1160-2120	
PL242 Part of 1160-2740	Banana, with special mount	1160-2120	24655	1160-2120	
PL301 through PL308	Banana, with special mount	1160-2120	24655	1160-2120	

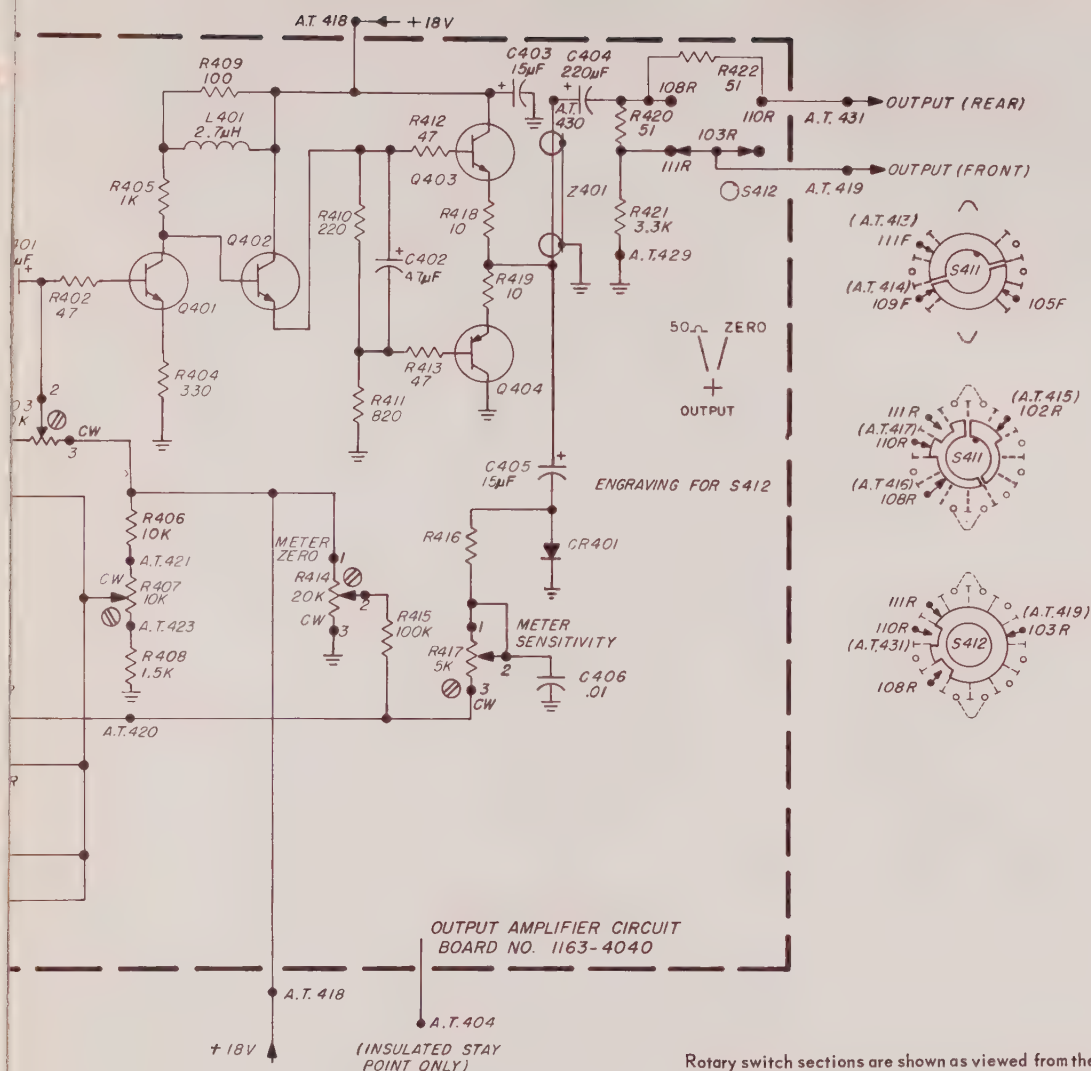
ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
RESISTORS					
R100	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$ 1/4 W	5905-681-0462
R101	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$ 1/4 W	5905-681-0462
R102	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$ 1/4 W	5905-681-0462
R103	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$ 1/4 W	5905-681-0462
R104	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$ 1/4 W	5905-681-0462
R105	Composition, 470 Ω $\pm 5\%$ 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm 5\%$ 1/4 W	5905-683-2242
R106	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$ 1/4 W	5905-681-0462
R107	Composition, 180 Ω $\pm 5\%$ 1/4 W	6099-1185	75042	BTS, 180 Ω $\pm 5\%$ 1/4 W	5905-279-5476
R108	Composition, 100 Ω $\pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm 5\%$ 1/4 W	
R109	Composition, 51 Ω $\pm 5\%$ 1/4 W	6099-0515	75042	BTS, 51 Ω $\pm 5\%$ 1/4 W	
R401-1 through R401-7	Composition, 1.5 k Ω $\pm 5\%$ 1/2 W	6100-2155	01121	RC20GF152J	5905-841-7461
R402	Composition 330 Ω $\pm 5\%$ 1/2 W	6100-1335	01121	RC20GF331J	5905-192-3971
SWITCHES					
S201	Special rf assembly	1160-2741	24655	1160-2741	
S202-1	Special rf assembly	1160-2741	24655	1160-2741	
S202-2 through S202-7	Special rf assembly	1160-2740	24655	1160-2740	
S401-1 through S401-7	Switch, part of DI dial assembly	1160-2100	24655	1160-2100	
S402	Switch, part of CAD dial assembly	1160-2090	24655	1160-2090	
S403	Toggle, DPST	7910-1300	04009	83053-SA	5930-909-3510
TRANSISTORS					
Q401-1 through Q401-7	Type 2N1304	8210-1304	01295	2N1304	5961-892-0800
CIRCUIT-BOARD ASSEMBLIES					
—	Lamp control (DI Station)	1160-2100	24655	1160-2100	
—	Lamp control (CAD Station)	1160-2090	24655	1160-2090	
—	Assembly, output amplifier, etched-circuit board	1163-4040	24655	1163-4040	
MISCELLANEOUS					
—	Knob, RDI-4 control	1163-1300	24655	1163-1300	
—	Knob, DI control	1160-1300	24655	1163-1300	
—	Knob, CAD control	1160-1310	24655	1160-1310	
—	Knob, pointer skirt	5530-0400	24655	5530-0400	
M401	Meter, edgewise, panel, 100-0-100 μ A $\pm 3\%$ 461 Ω $\pm 20\%$	5730-1382	81030	Meds 1382	
P401-1 through P401-8	Lamp, incandascnt, (Part of 1160-2080)	5600-1060	24655	5600-1060	
SO201	Connector, multiple	4230-2706	95354	CD606SF	

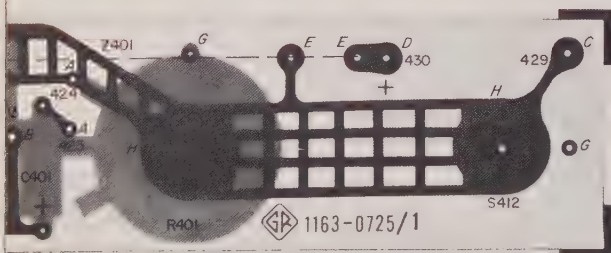


MECHANICAL PARTS LIST

Quantity	Ref. No.	Name	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
1	1	Dial strip	Dial strip	1163-8000	24655	1163-8000	
2	7	Dial and knob asm.	Dial and knob asm.	1160-1320	24655	1160-1320	
	7		Dial	1160-7320	24655	1160-7320	
	7		Knob including retainer 5220-5402	5520-5232	24655	5520-5232	
3	2	Comma	Comma	1160-8762	24655	1160-8762	
4	1	Cabinet	Cabinet	1160-1474	24655	1160-1474	
5	1	Decimal point	Decimal point	1160-8761	24655	1160-8761	
6	1	Dial and knob asm.	Dial and knob asm., CAD	1160-1310	24655	1160-1310	
	1		Dial	1160-7310	24655	1160-7310	
	1		Knob including retainer 5220-5402	5520-5232	24655	5520-5232	
7	1	Mode switch lever	Mode switch lever	1160-2160	24655	1160-2160	
8	2	Handle	Handle	5360-2012	24655	5360-2012	
9	8	Switch	Push button switch, CAD OFF and DIGIT DISABLE	1160-2360	24655	1160-2360	
10	4	Foot	Foot, soft, black neoprene	5260-0170	24655	5260-0170	
11	1	Nut	Dress nut, 15/32-32, 7/16	5800-0800	24655	5800-0800	5310-344-3634
12	1	Knob asm.	Knob, OUTPUT LEVEL, including retainer 5220-5402	5520-5221	24655	5520-5221	
13	2	Nut	Dress nut, 3/8-32, 7/16	5800-0799	24655	5800-0799	5310-991-7168
14	1	Knob asm.	Knob, OUTPUT VOLTS, including retainer 5220-5402	5500-5221	24655	5500-5221	
15	2	Spacer	Spacer	7800-0600	24655	7800-0600	5340-738-6516
16	2	Insulator	Insulator	0938-7130	24655	0938-7130	
17	2	End frame asm.	End frame asm.	5310-9632	24655	5310-9632	
18	1	Dial and knob asm.	Dial and knob asm. (12 digits)	1163-1300	24655	1163-1300	
—	1	Lamp holder	Lamp holder, CAD, includes lamp	1160-2081	24655	1160-2081	
—	7	Lamp holder asm.	Lamp holder, includes lamp	1160-2080	24655	1160-2080	
rear	2	Dress nut	Dress nut	1160-6570	24655	1160-6570	
rear	2	Clamp bracket	Clamp bracket	1160-8023	24655	1160-8023	
rear	1	Plug support bar	Plug support bar	1160-8024	24655	1160-8024	



BB-5.
Output Amplifier 1163-4040.



lifier.

umber
tran-

SERVICE INSTRUCTIONS

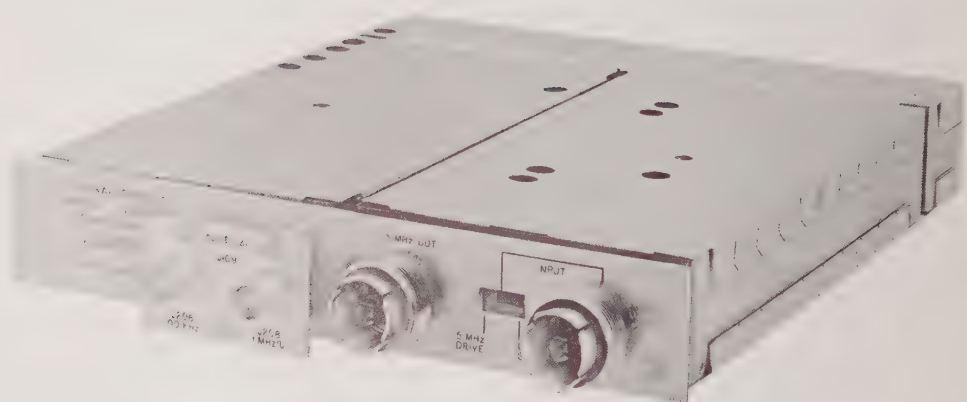
section **CB**

ANCILLARY FREQUENCY SOURCE, AFS-1B

P/N 1160-4011

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Ancillary Frequency Source — AFS-1B

SECTION CB-1

INTRODUCTION

CB-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension by experienced service personnel of the principles of operation. A trouble-analysis procedure that will aid in the isolation of defective circuits completes the section.

To facilitate part identification, reference designators used in the text and on the photographs are the same as those used on the complete schematic diagram and in the parts list. The reference designators are silk-screened on the module as a further aid in part location.

The service instructions rely on the use of an otherwise properly functioning synthesizer as a basic test frame for the suspect module. The instrument can be used to support the module in a convenient bench-service position and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the widespread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

CB-1.2 PURPOSE.

The Ancillary Frequency Source (hereafter referred to as AFS) is the electrical starting point for all General Radio frequency synthesizers. Its purpose is to furnish the frequency reference for the entire instrument. The AFS ac-

complishes this either by the processing of an external signal for use as the reference frequency standard for the instrument, or by provision of an internal source for this reference, at the user's option. It also supplies a selected group of fixed frequencies, coherently derived from the reference, for use in, and (optionally) external to, the remainder of the frequency synthesizer.

The AFS module plugs into the lower section of the main sandwich deck, at the left-hand side of the instrument. It engages 11 banana plugs projecting from the sandwich deck. From these interconnections, power is applied to the AFS through 2 plugs and output signals are taken from the AFS through the remaining 9. Electrical ground connection is made by physical contact between the AFS and the sandwich, when the two large mounting screws are in place.

CB-1.3 DESCRIPTION.

CB-1.3.1 Mechanical Layout.

The AFS module is an assembly of three etched-circuit boards that contain all of the electrical parts in the AFS circuitry. Along the perimeters of the etched boards are sheet-metal rails that provide electrical shielding and mechanical support for the entire assembly. The three boards are attached to each other and to the rear panel by machine screws.

The rear panel carries five connectors and a slide switch:

J107 — A locking GR874[®] connector that, in conjunction with the slide switch, provides an input for an optional reference signal.

J108 — Another locking 874 connector that gives access to a fixed 5-MHz output.

J109 — A pin jack that provides dc control of the internal crystal oscillator frequency when no lock signal or external input is present.

J206 — A BNC jack connector for a 100-kHz sinusoidal output.

J208 — A BNC jack connector for a 1-MHz, 40% duty cycle, pulsed output.

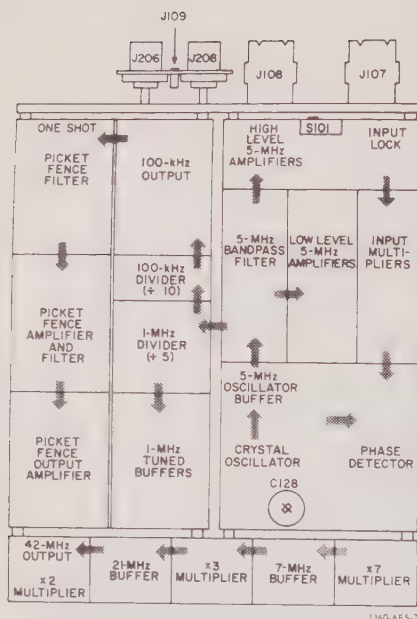


Figure CB-1. Functional layout diagram for AFS-1B (viewed from component side).

Six sheet-metal covers with integral, formed-contact fingers enclose the three etched-board assemblies. The three bottom covers are secured to the unit by 4-40 screws; the top covers are sandwiched between the chassis and the AFS when the unit is mounted in the synthesizer. The internal adjustments are not affected by the presence or absence of the covers, thereby permitting removal for alignment purposes. It is not necessary to remove the AFS from the chassis to remove the bottom covers; nor is it necessary to remove any cover but that of the section being serviced.

The mounting screws for the unit are two 10-32 x 1-3/8-in. Phillips-head screws projecting through bushings near the centers of the two larger boards in the AFS. They screw into threaded inserts in the sandwich deck.

Interconnections between the three circuit assemblies are made with wires and cables soldered to eyelets on the component side of the boards; the lines pass through holes in the side rails.

Reference to the pictorial layout of Figure CB-1 shows the location of various circuits in the module; signal flow is also indicated. The circuits are divided and positioned to provide maximum isolation, logical signal flow, and minimum interconnection between etched boards.

Table CB-1
DIRECT OUTPUT FREQUENCIES

Frequency	Source	Available	Used by	Approximate Level
5.0 MHz	Crystal Oscillator in AFS	J106	DI (Station 7), CAD	1 V into 50 Ω
		J104	Output Mixer Units	300 mV into 1 k Ω
		J108	For optional external use	1 V behind 50 Ω
1.0 MHz	Divided from 5.0 MHz	J201	RDI-4 or RDI-2, when present	1 V into 1 k Ω
		J208	For optional external use	Pulse, 40% duty cycle, 2.2 V pk behind 1 k Ω
100 kHz	Divided from 1 MHz	J206	For optional external use	1 V behind 50 Ω
42 MHz	Multiplied from 1.0 MHz	J301	DI units and CAD unit	1 V into 100 Ω
Picket Fence 10 frequencies 100-kHz spacing 3.0–3.9 MHz	Selected group of harmonics of 100 kHz	J203	DI units	400 mV into 7 Ω per component
		J204		
		J205		

CB-1.3.2 Electrical Characteristics.

The AFS module contains the master oscillator, from which are derived all frequencies in the synthesizer (except for the free-running continuously adjustable oscillators in the CAD unit). Table CB-1 lists the outputs of the AFS unit. See the over-all schematic in Sections BA, BB or BC for the interconnecting wiring by which the outputs are distributed throughout the synthesizer.

An input jack, J101, on the AFS module accepts a dc voltage from the front-panel potentiometer (R407) labeled CRYSTAL FREQ. This voltage is fed to a varactor diode in the crystal-oscillator circuit to control the crystal frequency by small amounts.

J109 on the rear panel provides another dc input to the varactor. This terminal, in effect, allows remote control of the crystal frequency. One possibility for use of J109 is the application of a controlling signal from a phase-detector system. The dc voltage at J109 should be restricted to ± 3 V; the actual control sensitivity depends on the front-panel CRYSTAL FREQ control.

In addition, circuits are available in the AFS to lock the internal 5-MHz quartz oscillator to an equivalent (or superior) external standard. This feature allows any one of the several commonly available frequencies from standard-frequency-distribution systems to function as the reference for the synthesizer. Thus, the synthesizer can be referenced to a laboratory standard or other equivalent laboratory instrument. Alternatively, the internally derived 5-MHz, 1-MHz, and 100-kHz signals are available from J108, J206 and J208 to reference other instruments to the synthesizer.

The GR locking circuit will operate from any standard frequency from 100 kHz to 5 MHz (with an amplitude

between 0.1 and 5 V, rms), provided the frequency is an integral submultiple of 5 MHz. This signal must be fed into J107, a GR874 connector at the rear of the AFS unit, marked INPUT. An automatic frequency multiplier chooses the harmonic number necessary to multiply the external reference frequency to 5 MHz. The resulting signal is fed to a phase detector, whose output signal locks the internal 5-MHz quartz oscillator to the external reference.

The CRYSTAL FREQ control mentioned earlier, when used with an external reference, can bring the internal crystal-oscillator frequency close enough to the external standard so that the quartz oscillator is captured and locked. The phase-detector error signal is brought out of the AFS (via J103) to deflect the front-panel monitor meter, when the MONITOR switch is set to LOCK TO EXT STD to show the condition of the phase lock.

If a pure 5-MHz signal is available (i.e., without noise or sidebands) and it is desirable to by-pass the internal crystal phase-lock system, the slide switch at the rear of the unit should be moved to the EXT 5 MHz position. Again, the level of the 5-MHz signal should be between 0.1 and 5 V, rms. In this mode the reference stability is improved, no monitoring of the lock condition is required, and the LOCK TO EXT STD position on the synthesizer front-panel meter does not function. Also the reference standard can be as much as ± 1 kHz* from nominal 5 MHz, for applications requiring a wider range of reference frequencies. Use of this feature is restricted to 5 MHz, however, and the filtering action of the phase-lock is lost, making the instrument more susceptible to contamination on the reference.

*Except in the 1164 Synthesizer, where a crystal filter in the DI-3 and RDI-3 modules restrict this frequency pulling to about ± 150 Hz.

SECTION CB-2

PRINCIPLES OF OPERATION

CB-2.1 GENERAL

In this section, reference will be made to the schematic diagrams as noted: Figure CB-9 is the functional block diagram of the entire module, while the three etched-board diagrams are separate. Figure CB-10 shows the Master Frequency Section, Figure CB-11 the Picket Fence Section, and Figure CB-12 the 42-MHz Multiplier Section.

NOTE

The figures are foldout diagrams at the end of this section.

In the elementary schematic diagram, the unit block diagram is seen divided into its three boards, with the circuits contained on each separated from each other.

CB-2.2 MASTER FREQUENCY SECTION (Figure CB-10).

CB-2.2.1 Basic Theory

The frequency from which all other frequencies in the synthesizer are coherently derived is 5 MHz. The 5-MHz source is selected via the INPUT switch, S101, on the rear panel of the AFS-1B. The switch allows selection of an external 5-MHz source, supplied to INPUT jack J107, or an internal room-temperature quartz oscillator. To use the internal oscillator, the switch must be in the LOCK SIG IN position. In this condition, J107 accepts an optional reference signal (from 100 kHz to 5 MHz) that phase locks the internal crystal. An external 5 MHz is the preferred choice, but the 5-MHz signal used must be free of noise and discrete sidebands for proper synthesizer operation. If a reference frequency other than 5 MHz is desired, or if the available external signal is not clean, the LOCK SIG IN mode allows the crystal oscillator phase-lock circuit to function as a filter. In the EXT 5 MHz mode, supply voltages to the internal oscillator and phase detector are cut off.

CB-2.2.2 Internal Quartz Oscillator

The internal reference oscillator is a modified Clapp-Gouriet circuit with a varactor diode, CR107, representing part of the load capacitance of the AT-cut, hermetically sealed, room-temperature quartz plate. CR107 allows electronic tuning of the oscillator frequency. Q102 is the oscillator transistor. A dc voltage enters J101 from the front-panel CRYSTAL FREQUENCY potentiometer; the voltage ranges from 1.5 to 10 V dc and is nominally 4 V. This voltage is applied through the phase detector, R129/R130, and the low-pass filter (R169 and R132) to the cathode of CR107. The anode of CR107 is normally at ground potential (since CR107 is reverse biased) through R167 and R168.

When the phase-lock system is functioning, the phase detector develops a voltage across R129 and R130 that adds or subtracts from the crystal-frequency control voltage to phase lock the crystal oscillator. Note that J109 (DC ΔF) is connected to the anode of CR107, allowing dc control of the crystal frequency when the crystal oscillator is not locked. The oscillator output is connected through R136 to the INPUT switch. Supply power for the oscillator and phase detector comes from pin 5 of S101 when LOCK SIG IN is selected.

CB-2.2.3 Input Squarer

The input-squaring circuit, IC101, functions whenever an input is connected to J107. The IC is a comparator with constant output level and produces a square wave independent of the input signal level or waveform (input signals can be pulsed or sinusoidal). When the LOCK SIG IN mode is selected via switch S101, the output of IC101 is differentiated to pulse Q101 at the input reference rate. If EXT 5 MHz is selected, the output of IC101 becomes a leveled input signal that is fed to pin 2 of S101, to drive the 5-MHz circuits and the remainder of the AFS.

CB-2.2.4 5-MHz Buffers and Distribution Amplifiers

The 5-MHz signal, from either source previously described, traverses the bandpass filter (T101, T102, etc.) and goes to the common-emitter amplifier, Q103. The gain of Q103, and therefore the 5-MHz level in the AFS, is adjusted by the emitter bypass network (R145). The remainder of the AFS buffers (Q104 – Q108) are all emitter-follower amplifiers with unity voltage gain; the buffers are used to isolate the various outputs. Two voltage levels are employed. The high-level signal, 1 V rms from the collector of Q103, goes through Q107 and Q108, one for the rear-panel via Q108 and J108 and the other to the chassis via Q107 and J106. The low-level output (300 mV from R147) drives the phase detector through Q104, the OMM units via Q105 and J104, and the 1-MHz divider board of the AFS via Q106.

CB-2.2.5 Input Lock Circuits

As previously described, when phase lock of the internal reference is selected, and an optional input between 100 kHz and 5 MHz is fed to J107 (note that the input must be a sub-multiple of 5 MHz), the input circuit produces a pulse that is differentiated and applied to Q101. This differentiated pulse provides excitation for a 5-MHz bandpass filter (L101, L102, etc.) that selects the 5-MHz harmonic from the pulse. The amplitude of the 5-MHz output at L102 depends on the harmonic number, so a limiting amplifier, IC102, is provided to produce a constant 5 MHz, independent of the effective harmonic number referred to the input.

IC102 is a comparator like IC101, capable of triggering on the lowest signal level expected from L102. The output 5-MHz square wave from IC102 drives the phase-detector summing amplifier, IC103; IC103 takes the sum and difference signals between the 5 MHz from IC102 and the 5 MHz from the crystal oscillator via Q104. The sum and difference peaks are detected and subtracted with doubling peak detector CR103 – CR106, to produce the phase information added algebraically to the voltage at J101. The phase detector output is also fed to the front-panel meter circuit via J103, to give a monitor signal on the condition of the phase lock.

When EXT 5 MHz is selected, IC101 functions as a limiting amplifier for the input signal, driving the bandpass filter (T101, T102, etc.) through R112 and S101.

CB-2.3 PICKET-FENCE SECTION (Figure CB-11)

CB-2.3.1 General

The second large etched board in the AFS, called the Picket-Fence Section (P/N 1160-2805), contains all the circuits required in the generation of the picket-fence frequency band, plus the dividers to develop the frequency band proportionally from 5 MHz.

CB-2.3.2 Dividers

The division from 5 MHz to 1 MHz and from 1 MHz to 100 kHz is accomplished by IC201 and IC202.

The 5 MHz signal from the Master Frequency Section (Q106) is processed by Q201 and Q202 to provide a 5-MHz prf pulse suitable for IC201. IC201 contains two divider

circuits, a scale-of-5 and a scale-of-2. The scale-of-5 circuit is driven by Q201 at pin 6 and has three outputs. One output, at 1 MHz, has a duty cycle of 20% and triggers IC203. The second output is a 40%-duty-cycle pulse and is the 1-MHz source for emitter follower Q217. (Q217's output is available at J208 on the rear panel for external use.) The third output contains a burst of two 20%-duty-cycle pulses every microsecond. This burst drives the divide-by-2 circuit to produce a 40%-duty-cycle pulse for a well-isolated 1-MHz input signal to the tuned buffers (Q204/T201, and Q205/T202).

The division to 100 kHz is performed in an identical circuit, IC202. In this case the scale-by-5 circuit is driven by the pulse from IC201. The 200-kHz output drives the divide-by-2 circuit, resulting in a 100-kHz square-wave output.

CB-2.3.3 Buffer Amplifiers

As mentioned in paragraph CB-2.3.2, there are 1-MHz buffers in this part of the circuit. Q217 provides an isolated pulse at 1 MHz, 40% du, for external use at J208. The two tuned buffers provide clean outputs suitable for multiplication to higher frequencies. Q204 and T201 provide a 1-MHz signal to the remainder of the synthesizer via J201, while the output of Q205 and T202 drives the 42-MHz Section of the AFS, as described in paragraph CB-2.4.

The output of IC202, a 100-kHz square wave, is fed to a fixed low-pass filter (L211, L212, etc.). The resulting 100-kHz sine wave feeds an emitter follower, Q207, that is the source for output jack J206.

CB-2.3.4 Picket-Fence Generator

The core element of the Picket-Fence Section is the one-shot pulse generator, Q209 and Q210, driven by pulse amplifier Q208; the 100 kHz from IC202 is differentiated to drive Q208. In the circuits following this generator, the appropriate harmonics of 100 kHz are enhanced, while some of the unwanted harmonics are suppressed.

The 100-kHz rectangular-pulse train emanating from the pulse generator contains harmonics of 100 kHz, which have an amplitude characteristic whose envelope is described by

the $\frac{\sin x}{x}$ function.

The positions of the nulls depend on the ratio of t_i/T_o (see Figure CB-2). In the Picket-Fence generator, the t_i/T_o duty ratio of the pulse is set to 0.0415, placing the first and

second nulls of the $\frac{\sin x}{x}$ envelope at approximately 2.4 and

4.8 MHz, respectively. The pulse width is adjusted with C221, the time constant being determined primarily by C221, C220, and R233. When the pulse is adjusted to a width of 0.415 μ s, the desired output band, 3.0-3.9 MHz, is centered in the second lobe of the response envelope, with the end pickets (3.0 and 3.9 MHz) drooping about 1.5 dB in amplitude below the center components.

The remaining selectivity in the Picket-Fence Section arises from two tunable band-pass filters. The combined responses of these filters place two peaks near 3.0 and 3.9 MHz, with a 1.5-dB dip in the middle, to compensate for the peak in the output envelope of the pulse generator. The

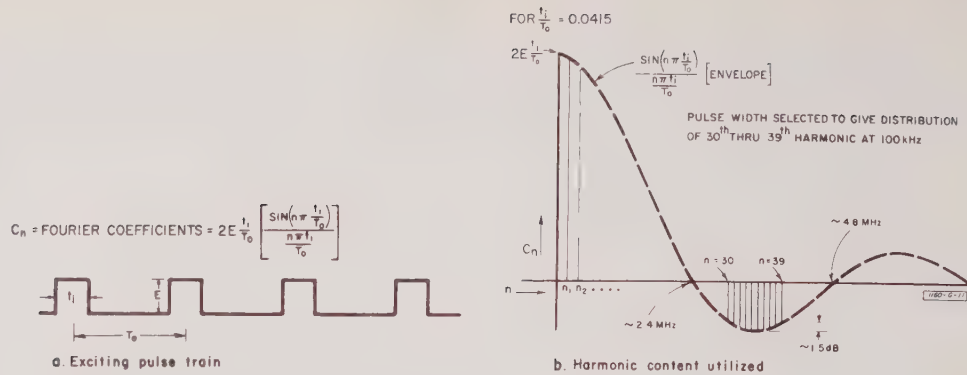


Figure CB-2. Picket Fence frequency-generation technique.

picket-fence circuit sequence is shown in Figure CB-9 to be the first filter L201-L202, followed by a buffer (Q213 and Q214), with adjustable gain via R241. Then, a second filter (L205, L206, etc.) is followed by a push-pull driver stage, Q213 and Q214, and a push-pull output stage, Q215 and Q216; all are transformer coupled.

The balanced output goes to the Picket Fence feed lines in the sandwich deck, via J203 and J205 into PL105 and PL106. J204, the center tap at the output transformer, is grounded in the sandwich deck via PL104.

CB-2.4 42-MHz SECTION (Figure CB-12).

The section of the AFS used to generate the 42-MHz signal is mounted on the small board (P/N 1160-2808). It is

driven by the 1-MHz amplifier, Q205, in the Picket-Fence Section. The system consists of the following elements in order (see Figure CB-9). First, a X7 transistor-multiplier (differential amplifier Q301/Q302) with a 7-MHz tuned circuit (L302, etc.), and a 7-MHz buffer with double-tuned, top-C coupled, bandpass filter, L303/L304. Next, a X3 multiplier produces 21 MHz, with T301 as the output tank followed by a 21-MHz buffer Q306/T302 and a diode doubler CR301 and CR302. A X2 multiplier, Q307/T303, multiplies the 21-MHz signal to 42 MHz, and couples the 42-MHz signal to J301.

SECTION CB-3

SERVICE AND MAINTENANCE

CB-3.1 GENERAL.

If the system trouble-analysis procedures of Section 5 at the front of the manual indicate possible malfunction of the AFS unit, the most positive verification of this suspicion is the substitution of another AFS module.

Since there is but one AFS module per instrument, and since service spares may not be available, it will not always be possible to make the substitution. However, selected tests, and most alignment procedures can be made in the field.

A thorough knowledge of the principles of the operation of this module is essential before service is attempted.

CB-3.2 TEST EQUIPMENT RECOMMENDED.

Table CB-2 lists the equipment recommended for service of the AFS modules. Equivalent equipment may be substituted.

CB-3.3 REMOVAL FROM CHASSIS.

CB-3.3.1 Removal From Chassis

Removal of the AFS is accomplished as follows:

- a. Remove the synthesizer from the case; invert the instrument assembly.
- b. Remove the two large screws that attach the AFS to the chassis.
- c. Grasp the AFS module and pull straight up.

CB-3.3.2 Removal of Covers

Cover removal is accomplished, for the bottom covers, by removing the appropriate screws; the covers can then be pried off. The top covers are sandwiched between the unit and the chassis and can be removed only when the AFS is out of the chassis. With all covers removed, the AFS can be reinstalled in the chassis (with the two large screws), to provide power and loads for service and maintenance operations.

Alternatively, the bottom covers can be removed for testing without removing the AFS from the chassis.

NOTE

Electrical performance of the unit is not adversely affected by lack of the cover, except small signal leakages may degrade spurious performance of the synthesizer itself.

CB-3.3.3 Reassembly

Installation of the covers is the reverse of the above. Make sure that the covers, as they are installed, engage the unit properly with their fingers. Be sure to use each cover with its appropriate circuit board, since each cover is different.

CB-3.4 TROUBLE ANALYSIS

CB-3.4.1 General

Malfunction within an AFS module, as indicated by the system trouble-analysis procedures found in Section 5 at the front of the manual, can be isolated further here. The indications obtained from external connectors and test points on the synthesizer can be used to localize the difficulty to a particular circuit. In the procedures that follow, the shield covers must be removed from the AFS unit to permit access to interior test and adjustment points (refer to paragraph CB-3.3).

In the performance of these tests the synthesizer Main Frame chassis is used to support the AFS unit, and the other modules are used to power it and to supply loads for its outputs. All modules or bridging units should be in place.

With the case removed from the synthesizer and the AFS unit installed (less shield covers), the instrument can be operated upside down on the test bench. The readings are the same whether or not the cover is in place.

Table CB-2
TEST EQUIPMENT REQUIRED

Function	Type Recommended	Minimal Characteristics
Electronic Voltmeter (VTVM)	GR1806	2% accuracy; ac and dc capabilities
Oscilloscope	Tektronix Model 543 (with C/A plug-in and P6006, 10 x passive probe)	20 MHz, 0.5 V/cm with 8 pF (or less) probe capacitance
Frequency Standard	GR1115	5-MHz and 100-kHz outputs, accurate to at least 1×10^{-6}
Termination (50-Ω)	GR 874-W50BL	0.5 % accuracy and GR874 connector
Digital Frequency Meter	GR 1191	Dc to 10 MHz; 0.1 V sensitivity, pk-to -pk
Standard Sweep-Frequency Generator	GR 1025	0.5 % calibration accuracy
Patch Cord	GR 874-R22LA	Coaxial with GR874 connectors
Tuned Voltmeter	Sufficient selectivity to separate picket-fence components, spaced 100-kHz apart from 3.0 to 3.9 MHz. A communications receiver with metered i-f output can be used with a signal generator to substitute for the measured quantity, to establish the picket-fence component amplitude.	

CB-3.4.2 POWER-SUPPLY INPUTS.

Measure power-supply input voltages first. Two power-supply input connections are made to the AFS, via J105 and J202 of the AFS; these voltages should be $+18 \pm 0.2$ V dc. If they are not in this range, tests should be made elsewhere in the system to correct this problem (refer to Sections BA, BB, BC, GA, GB, or GC).

CB-3.4.3 EXTERNAL STANDARD INPUT CIRCUITS.

NOTE

This circuitry is confined entirely to the AFS unit except for the front-panel control and monitor connections. Input switch S101 should be in the LOCK SIG IN position.

If the system does not lock, as indicated by the front-panel MONITOR meter, make sure that the free-running crystal-oscillator frequency is exactly 5 MHz, near the center of the range of the front-panel CRYSTAL FREQ control. Measure the frequency with the digital frequency

meter connected to J108. If the frequency is not correct, set C128 so that 5 MHz occurs near the center of the CRYSTAL FREQ control range (refer to Table CB-5). If this does not clear up the difficulty, measure the dc voltage at J101, to determine that when R407, the CRYSTAL FREQ control is rotated, it affects the dc voltage at this point. Refer to Table CB-3 for the range of this adjustment. With no lock-signal input, the voltage at J103 should follow the CRYSTAL FREQ control and the voltage at J101.

When it has been determined that R407 is functioning normally, a 100-kHz signal should be fed into the input jack, J107, from the frequency standard. Check the input circuits (IC101, Q101, IC102 and IC103) with the procedures of Table CB-5.

These checks should be sufficient to localize any malfunction in the multiplier to a single circuit. A check should also be made to ensure that a 5-MHz signal is being fed into the phase detector via Q104. If the circuit still fails to lock, check the line fed to the varactor CR107, through R132. A check should also be made to see that S101 functions properly in the EXT 5 MHz mode, if a 5-MHz standard is available.

Table CB-3
OPERATING VOLTAGE SPECIFICATIONS
(See Figures CB-4 and CB-6)

INPUTS

Jack	Description	Source/Load	Measure With	Measured Level	Frequency
J105	Power Supply No. 1 Input	Internal	Dc VTVM	+18 V ± 0.2 V with respect to ground.	—
J202	Power Supply No. 2 Input	Internal	Dc VTVM	+18 V ± 0.2 V with respect to ground.	—
J101	Crystal Frequency Control	Internal	Dc VTVM	$\approx +1.5$ to $+8.0$ V dc. Nominally $+4$ V dc. Controlled from front panel of synthesizer.	—
J107 (Optional)	Input	Frequency Standard	Ac VTVM	0.1 to 5 V rms.	Any integral submultiple of 5 MHz —100-kHz to 5 MHz for phase-locking. 5 MHz when substituting for internal oscillator.
J109	DC Δ F	Dc supply or phase detector	Dc VTVM	± 3 V max.	

OUTPUTS

J108	5-MHz Output	874-W50BL	Ac VTVM	0.7-1.0 V, rms	5.00 MHz ± 20 Hz
J206	100-kHz Output	BNC	Ac VTVM	0.5-1.0 V, rms	100 kHz
J208	1-MHz Output	BNC	Oscilloscope	0.5-1.0 V, rms	1 MHz
J104	5 MHz to Mixer	Internal	Ac VTVM	0.3 V, rms, $\pm 10\%$	5.00 MHz
J106	5 MHz to Digits	Internal	Ac VTVM	1.0 V, rms, $\pm 10\%$	5.00 MHz
J201	1-MHz Output	Internal	Ac VTVM	0.7-1.0 V, rms	1.00 MHz
J205	Picket-Fence Output	Internal	Tuned Voltmeter	0.4 V, rms, per component — 3.0-3.8, $+10$, -15% 3.9, $+10$, -20%	30, 31, 32 39th harmonic of 100.0 kHz
J301	42-MHz Output	Internal	Ac VTVM	1.0 V, rms, $\pm 10\%$	42.00 MHz
J103	Crystal-Lock Monitor Output	Internal	Dc VTVM	Same as J101 above with no signal at J107. Error voltage of phase detector when dc signal at J107 is present.	

Notes

Voltages measured in a properly operating and loaded AFS unit with input voltages supplied by synthesizer. The frequencies listed without tolerances are derived on a strict proportional basis from

the 5 MHz standard. If an optional external standard is driving J107, the internal standard and all proportionally derived frequencies should be exactly proportional to the driving standard.

CB-3.4.4 5-MHz Distribution Circuits

Several points in the system use a 5-MHz signal derived from different amplifiers in the AFS. These signals should be measured at various locations throughout the synthesizer to ascertain proper distribution. The 5-MHz signal should appear at J108 (rear of AFS), J151, the 5-MHz jack at rear of the chassis, and at the 5-MHz input to the CAD on the top of the deck (accessible when the CAD is removed). When the button under the CAD is depressed, the 5-MHz input signal to the CAD (PL213) is available at the "REF LINE" test point, TP101, on the left-hand end pan of the Main Frame chassis. It should be 300 mV, rms, $\pm 10\%$, except J108 where it is 0.7 – 1.0 V, rms.

If any of these signals is absent, a check for shorts or opens in the system interconnecting wiring should be made (Section BA, BB, or BC). If no shorts or opens are present, the trouble lies in the AFS. The affected circuit can be found with the schematic diagrams and appropriate steps taken. The alignment procedure, Table CB-5, can be used as a guide.

CB-3.4.5 Frequency Dividers

Over-all operation of the dividers is best checked with an oscilloscope, observing the waveforms in the sequence described in Table CB-6. Presence of any of the lower signals, such as 1 MHz and 100 kHz, indicates normal operation. A division ratio check can be made by observing Lissajous figures between 5 and 1 MHz, and 1 MHz and 100 kHz. A 5:1 or 10:1 stationary Lissajous figure should be observed, respectively.

If the 1-MHz signal is not present at the sandwich-deck receptacle, look for it at J201 on the AFS. It would be well also to make a continuity check of the chassis-jack circuits to make sure that a short or open circuit has not developed there (refer to Sections BA, BB or BC).

CB-3.4.6 42-MHz CHECK.

The 42-MHz output feeding the RDI-1 units and CAD is made available at the rear of the chassis (J155 for Types 1161, 1162 and 1163 and J156 for Type 1164). This signal level can be measured with the electronic voltmeter.

If the signal is absent, check the 1-MHz signal at the rear of the sandwich (J152). If the 1-MHz signal is absent, the 1-MHz circuit should be restored to operation before further trouble analysis is attempted on the 42-MHz Section. If 1 MHz is present, check the waveform at AT302 to make sure that the X7 multiplier is getting 1 MHz through the coaxial cable.

If the 42-MHz signal is absent, but the 1-MHz circuit appears to be operating properly, trouble analysis should

center on the 42-MHz Section. This procedure can be done with reference to Table CB-7.

CB-3.4.7 Picket-Fence Section.

Operation of the Picket-Fence Section and distribution of its outputs can best be checked with an oscilloscope at the Main Frame test points labeled Picket Fence (TP101 in Types 1161/1162; TP101 and TP104 in Types 1163/1164). They are mounted on the left-hand end pan of the chassis. The waveform here and at J205 on the AFS should be compared with Figure CB-3 for approximate shape and amplitude.

If the picket-fence signal is present, but indications in the system are that the Picket-Fence Section is generating the wrong frequencies, check the dividers as in paragraph CB-3.4.5. If the picket-fence signal is absent completely, check for shorts in the Main Frame (Sections BA, BB, or BC) or in an individual RDI-1 unit.

If the Picket-Fence Section supply busses are not shorted in the chassis, or in an RDI-1 unit, the difficulty is in the AFS. The 100-kHz output (J206) should be measured next (Table CB-3). If this output is absent, the trouble may be in the dividers, IC101 and IC102.

If the 100-kHz signal is operative, check the pulse waveforms at Q209/Q210 (TP205) and then follow along the signal-flow path until the defective circuit is found. Refer to Table CB-6 for alignment details.

CAUTION

Normally C221 and R241 and the bandpass-filter tuning adjustments (C224, C226, C235 and C236) should not be disturbed.

CB-3.5 ALIGNMENT PROCEDURES.

If the trouble-analysis procedures of paragraph CB-3.4 indicate marginal performance of a circuit function, or if repairs or replacements have been made, realignment of the circuits in the AFS unit may be required; Table CB-4 lists special tools recommended. Material in Tables CB-5 through CB-7 presents the alignment procedures. Typical waveforms to be looked for appear in Figures CB-5, CB-7, and CB-8. Figures CB-4 and CB-6 show test points and secondary-adjustment controls.

CB-3.6 REPAIRS AND REPLACEMENTS.

If subnormal circuits don't respond to adjustments indicated in the alignment procedures, use the schematic diagrams of Figures CB-10 through CB-12 to localize the trouble area and replace defective detail parts. The parts list at the end of this section gives pertinent descriptive information on parts used and reference designators appearing there are the same as those used on schematics and photos. In most cases, the designators are silk-screened on the etched-circuit board to complete the identification.

As an aid to isolate the defective part, Table CB-8 lists dc voltages at transistor leads in all stages of a properly functioning AFS unit. Basing diagrams for the transistor types used are given on the schematic diagrams. The collector lead is identified by a dot on the foil side of the etched-circuit boards.

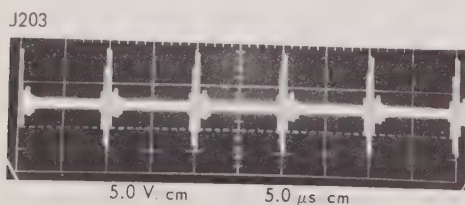


Figure CB-3. Picket-Fence waveform.

Table CB-4
ALIGNMENT TOOLS RECOMMENDED

Type Adjustment	Recommended Tool
Potentiometers	Any suitable screwdriver fitting the screw slot, or JFD #5284
Ceramic Capacitors	Insulated screwdriver with minimum metallic contact with screw slot, e.g. JFD #5284.
Internally threaded coil forms with threaded, powdered-iron slug	Insulated soft-tip screwdriver. JFD #5284 may be used if care is taken not to damage brittle powdered iron.

NOTE: JFD = JFD Electronics Corporation, Brooklyn, New York.

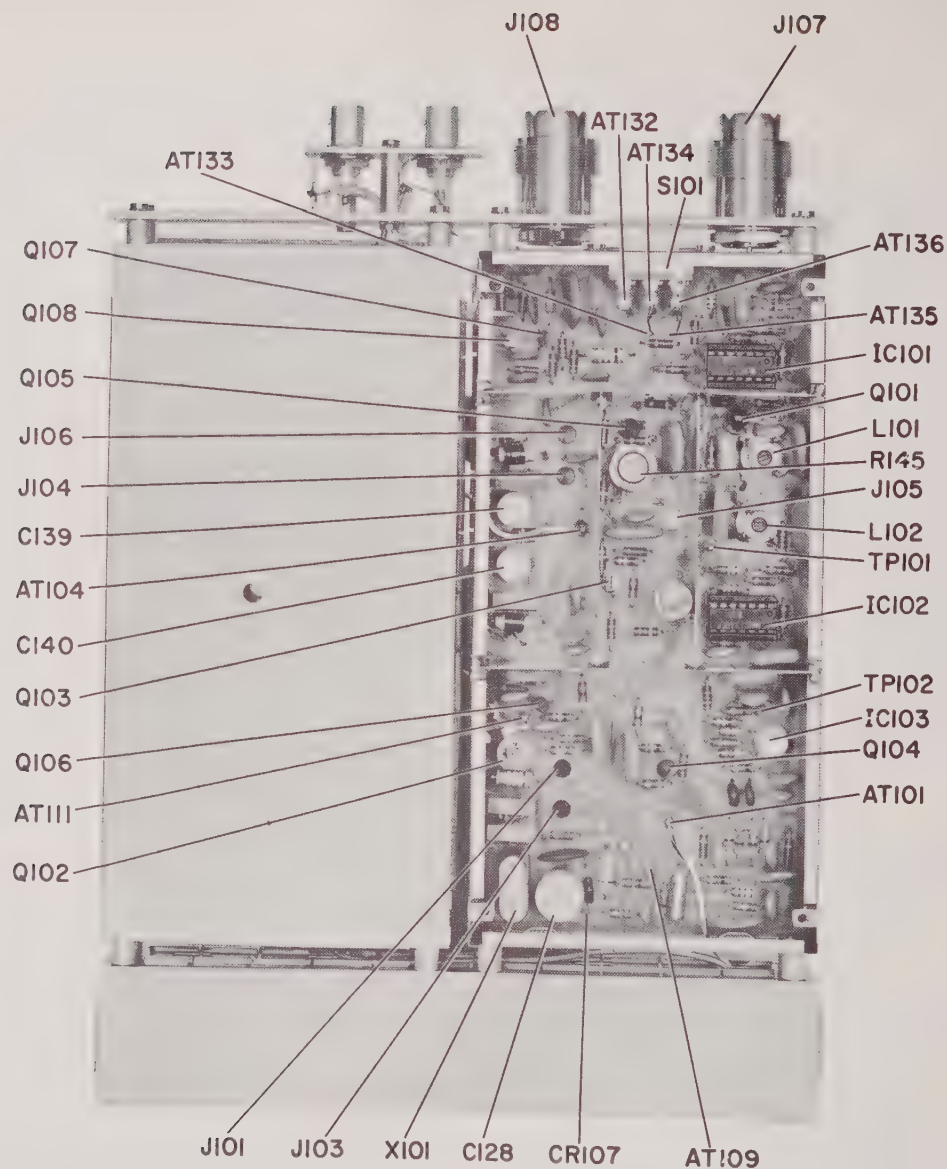


Figure CB-4. Master Frequency Section — test points and alignment controls.

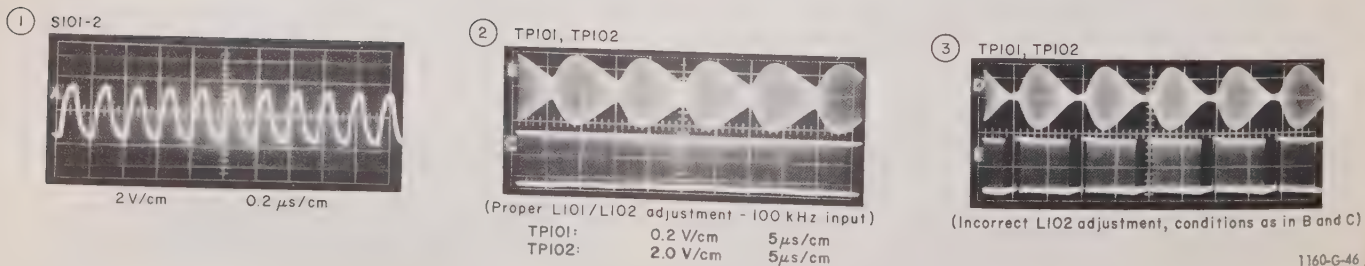


Figure CB-5. Master Frequency Section alignment waveforms.

Table CB-5
CIRCUIT ALIGNMENT CHECK CHART
MASTER FREQUENCY SECTION (Figures CB-4 and CB-5)

Test Set-up: AFS plugged into a normally functioning synthesizer chassis with all modules or bridging units in place, S101 in the LOCK SIG IN position, no input connected.

Circuit	Test Point	Instrument	Alignment Procedure
Crystal Oscillator Varactor Bias	J101	D	Set CRYSTAL FREQ (R407, front panel) for 4 V dc.
5-MHz Bandpass	J104	A	Tune C139 and C140 for maximum
	J104	A	Set to 300 mV rms with R145
	J108	C	Set C128 for 5 MHz ± 5 Hz. Retune C139, C140 and R145 as needed.
5-MHz Buffers	J108	A	Check for 0.7 to 1.0 V, rms, with 50 Ω load.
	J106	A	Check for 1.0 ± 0.1 V rms
Input Lock System Set-up: As before, except connect a cable from J206 to J107 (100 kHz output reapplied to INPUT).			
Input Circuit Check	S101-2 ①	O	Check waveform vs Figure CB-5A
Disconnect cable at J206; reconnect to J108 (5 MHz output reapplied to INPUT).			
5-MHz Bandpass Adjust	TP101 ②	O	Adjust L101 and L102 <i>carefully</i> for maximum at 5 MHz (See Figure CB-5B).
Disconnect cable from J108; reconnect to J206.			
5-MHz Bandpass Touch-up	TP101 ② ③	O	Adjust waveform for maximum signal at valleys by <i>slight</i> retuning of L101 and L102 (see Figure CB-5B). Figure CB-5D shows incorrect alignment of L101 and L102
Limiter Check	TP102 ② ③	O	Waveform should be as in Figure CB-5C; not as in Figure CB-5E.
Phase Lock Check: Connect external standards of 5 MHz ± 100 kHz to INPUT. Check for normal phase lock as in Sections BA, BB, or BC.			

Notes: The loop formed in the part lead is the test point. Instruments: D = Dc VTVM, A = Ac VTVM, O = Oscilloscope.

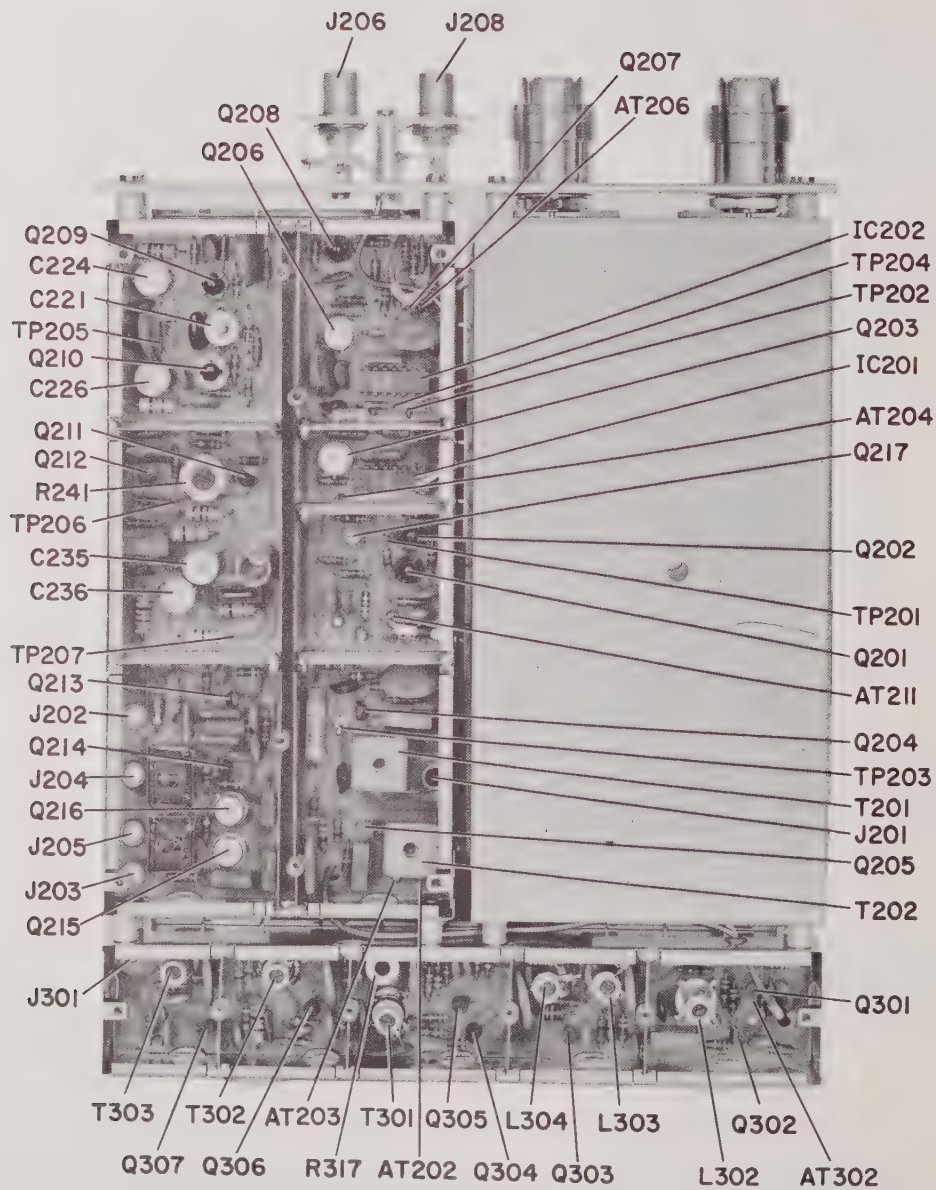


Figure CB-6. Picket Fence and 42-MHz Sections — test points and alignment controls.

Table CB-6
CIRCUIT ALIGNMENT CHECK CHART
PICKET-FENCE SECTION (Figures CB-6 and CB-7)

Circuit	Test Point	Instrument	Procedure
5-MHz Pulse Circuit	TP201 ④	O	Check waveform vs Figure CB-7A
1-MHz Pulse Check	TP202 ④	O	Check waveform vs Figure CB-7B
1-MHz Pulse Check	TP203 ⑤	O	Check waveform vs Figure CB-7C
1-MHz Buffer Tuning	J201 ⑤	O	Tune T201 for maximum at 1 MHz; check for 3.0 ± 0.6 V p-p (see Figure CB-7D).
1-MHz Buffer Tuning	TP301 ⑥	O	Tune T202 for maximum at 1 MHz; check for 3.00 ± 0.45 V p-p (see Figure CB-7E).
100-kHz Buffer	J206 ⑦	O	Check for 100-kHz sinewave, 0.5 to 1.0 V rms with 50Ω load (see Figure CB-7G).
One-Shot (Picket-Fence)	TP205 ⑦⑧	O	Check for pulse per Figures CB-7H and CB-7I.
Picket Fence	TP206 ⑧	O	Check for waveform as in Figure CB-7J.
	TP207 ⑨	O	Check for waveform as in Figure CB-7K.
	J203	O	Check for waveform as in Figure CB-3.
Picket Fence	J203/J205	V	Use a selective voltmeter, capable of tuning each significant frequency from 3.0 to 3.9 MHz. Level specifications are: 3.0 - 3.8 MHz: 0.4 V rms ± 10 , -15% 3.9 MHz: 0.4 V rms ± 10 , -20% If these limits cannot be attained, R241 and C221 can be retouched slightly to improve the picket fence distribution. C221 adjusts the Picket-Fence tilt from 3.0 to 3.9 MHz; R241 adjusts all levels equally.

Notes: The loop in a part lead forms the test point. Probes required. Instruments: O = Oscilloscope, V = VTVM.

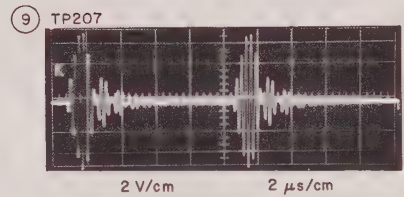
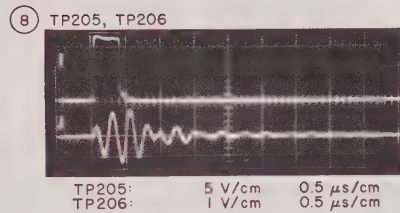
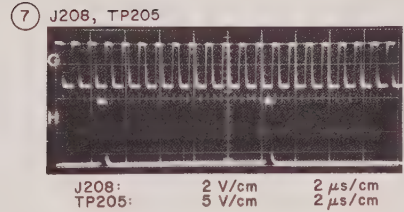
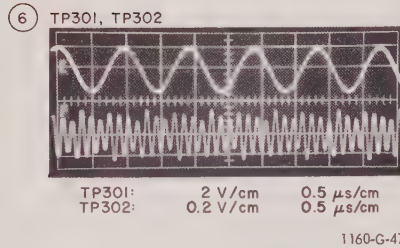
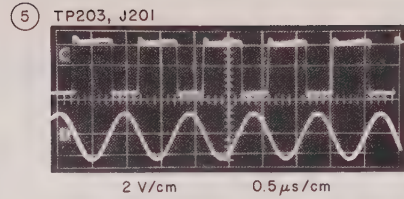
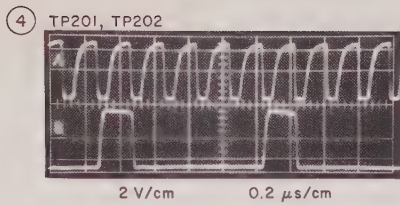
After the final step of Table CB-6, if the Picket-Fence still does not meet specifications, a swept-frequency response measurement can be made. Figure CB-7L shows the correct response. Apply a sweeper excitation of 0.2 V rms, sweeping from about 2.5 to 5 MHz, to TP205 (Q210 is

removed from the circuit for this procedure). Connect a detector probe to TP207 to observe the trace of Figure CB-7L. (The markers on Figure CB-7L are shown for the frequencies of interest.)

Table CB-7
CIRCUIT ALIGNMENT CHECK CHART
42-MHz SECTION (Figures CB-6 and CB-8)

Circuit	Test Point	Instrument	Procedure
7-MHz Multiplier	TP302 ⑥	O	Tune L302 for maximum at 7 MHz (see Figure CB-7F).
7-MHz Amplifier	TP303 ⑩	O	Tune L303 and L304 for maximum at 7 MHz. Retouch L302 for maximum (at TP303). See Figure CB-8A. (Note a slight interaction between L303 and L304.
21-MHz Multiplier Tuning	TP304 ⑩	O	Tune T301 for maximum at 21 MHz (see Figure CB-8B).
21-MHz Amplifier-Doubler Tuning	TP305 ⑪	O	Tune T302 for maximum at 42 MHz (see Figure CB-8C).
42-MHz Output Amplifier	J301	V	Tune T303 for maximum at 42 MHz. Retune T301 and T302 slightly as needed.
42-MHz Level Set	J301	V	Adjust R317 for 1 V rms.

Notes: The loop in a part lead forms the test point. Probes required. Instruments: O = Oscilloscope, V = VTVM.



Swept response. Markers 3.0-3.9 MHz. Driver at collector of Q210.

Figure CB-7. Picket-Fence Section alignment waveforms.

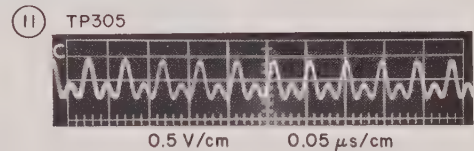
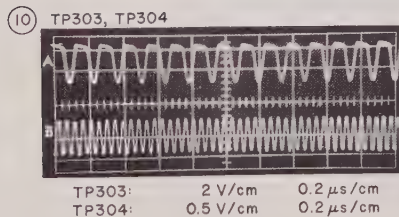


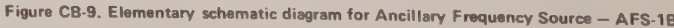
Figure CB-8. 42-MHz Section alignment waveforms.

TABLE CB-8
DC VOLTAGES – AFS-1B

<i>Transistor</i>	<i>Emitter</i>	<i>Base</i>	<i>Collector</i>
Q101	0	0	18.0
Q102	7.8	7.1	—
Q103	13.0	12.3	6.4
Q104	11.6	12.3	17.8
Q105	13.3	14.0	17.8
Q106	11.5	12.2	17.8
Q107	12.2	11.5	8.9
Q108	5.8	6.5	8.9
Q201	3.4	2.9	0.56
Q202	—	0.56	1.025
Q203	5.0	5.7	18.0
Q204	13.0	12.3	—
Q205	13.0	12.3	—
Q206	5.0	5.7	18.0
Q207	10.8	11.5	16.5
Q208	0.01	0	17.0
Q209	4.5	4.5	17.0
Q210	5.3	6.0	6.0
Q211	13.0	13.7	17.8
Q212	13.7	13.0	0.45
Q213	9.2	9.9	18.0
Q214	8.9	8.2	—
Q215	0.35	0	18.0
Q216	0.35	0	18.0
Q217	1.15	1.45	16.5
Q301	12.6	12.3	1.6
Q302	12.6	12.3	1.3
Q303	6.4	7.1	16.5
Q304	10.2	12.4	0.90
Q305	11.0	12.5	0.85
Q306	6.5	7.2	17.8
Q307	6.5	7.2	17.8

NOTES:

1. AFS plugged into fully equipped Type 1163-AR7C.
2. No input lock signal and no loads on 5-MHz and 100-kHz outputs.
3. All measurements made with Type 1806-A (direct-no probe).
4. Allow $\pm 10\%$ tolerance for all readings.



ELECTRICAL PARTS LIST

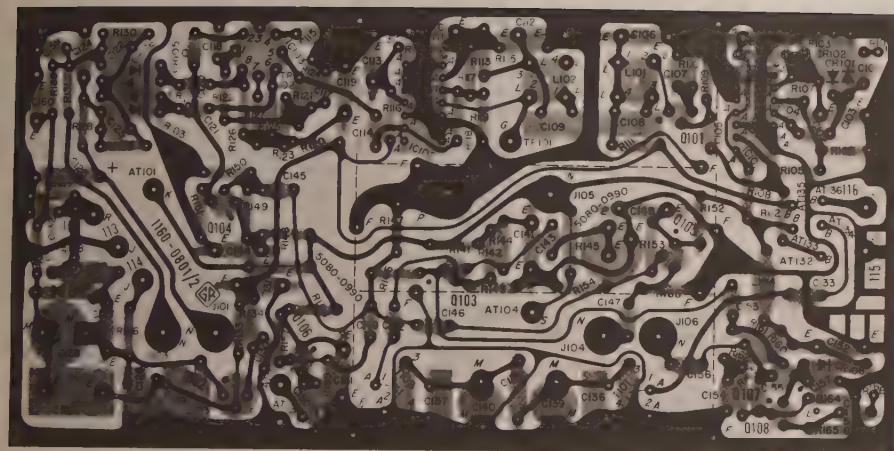
Ref. No.	Name	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. Code	Fed. Stock No.
CAPACITORS						
C101	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C102	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C103	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C104	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C105	Ceramic	27 pF $\pm$ 5% 500 V	4404-0275	72982	831, 27 pF $\pm$ 5%	
C106	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C107	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C108	Mica	220 pF $\pm$ 5% 500 V	4700-0519	14655	22A, 200 pF $\pm$ 5%	5910-974-5697
C109	Mica	220 pF $\pm$ 5% 500 V	4700-0519	14655	22A, 200 pF $\pm$ 5%	
C111	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C112	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C113	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C114	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C115	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C116	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C117	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C118	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C119	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C120	Ceramic	.001 μ F $\pm$ 20% 500 V	4404-2100	72982	831, .001 μ F $\pm$ 20%	
C121	Ceramic	.001 μ F $\pm$ 20% 500 V	4404-2100	72982	831, .001 μ F $\pm$ 20%	
C122	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C123	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C124	Ceramic	.02 μ F +80-20% 50 V	4402-3200	01121	35-203W	5910-952-8659
C125	Electrolytic	33 μ F $\pm$ 20% 10 V	4450-5400	56289	150D336X0010B1	5910-823-1623
C126	Mica	120 pF $\pm$ 5% 500 V	4700-0426	14655	22A, 120 pF $\pm$ 5%	
C127	Ceramic	51 pF N30 $\pm$ 5% 500 V	4411-0515	72982	811, 51 pF N30 $\pm$ 5%	
C128	Trimmer	5-25 pF NPO	4910-1150	72982	557-051 U2P0	
C129	Mica	.0015 μ F $\pm$ 5% 500 V	4700-0690	14655	22A, .0015 μ F $\pm$ 5%	
C130	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C131	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C132	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C133	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C136	Mica	68.1 pF $\pm$ 1% 500 V	4710-0005	14655	22A, 68.1 pF $\pm$ 1%	
C137	Mica	68.1 pF $\pm$ 1% 500 V	4710-0005	14655	22A, 68.1 pF $\pm$ 1%	
C138	Ceramic	1.5 pF $\pm$ 10% 500 V	4400-0159	78488	GA, 1.5 pF $\pm$ 10%	
C139	Trimmer	7 - 25 pF N300 350 V	4910-2043	72982	538-002, 7 to 25 pF N300	
C140	Trimmer	7 - 25 pF N300 350 V	4910-2043	72982	538-002, 7 to 25 pF N300	
C141	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C142	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C143	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C144	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C145	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C146	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C147	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C148	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C149	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C150	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C151	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C152	Ceramic	0.1 μ F +80-20% 50 V	4403-4100	80131	CC63, 0.1 μ F +80-20%	5910-811-4788
C153	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C154	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C155	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C156	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C157	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C158	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C159	Ceramic	.01 μ F +80-20% 50 V	4401-3100	80131	CC61, .01 μ F +80-20%	5910-974-5697
C160	Ceramic	.022 μ F +80-20% 500 V	4407-3229	72982	CC63, .022 μ F +80-20%	5910-842-2961

RESISTORS

R101	Composition	47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R102	Composition	1.8 k Ω $\pm$ 5% 1/4 W	6099-2185	75042	BTS, 1.8 k Ω $\pm$ 5%	5905-688-3738
R103	Composition	680 Ω $\pm$ 5% 1/4 W	6099-1685	75042	BTS, 680 Ω $\pm$ 5%	
R104	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R105	Composition	68 k Ω $\pm$ 5% 1/4 W	6099-3685	75042	BTS, 68 k Ω $\pm$ 5%	5905-681-8853
R106	Composition	390 k Ω $\pm$ 5% 1/4 W	6099-4395	75042	BTS, 390 k Ω $\pm$ 5%	
R107	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R108	Composition	100 Ω $\pm$ 10% 1/4 W	6099-1109	75042	BTS, 100 Ω $\pm$ 10%	
R109	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R110	Composition	390 Ω $\pm$ 5% 1/4 W	6099-1395	75042	BTS, 390 Ω $\pm$ 5%	
R111	Composition	3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	5905-681-9969
R112	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251

ELECTRICAL PARTS LIST (cont)

Ref. No.	Name	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. Code	Fed. Stock No.
RESISTORS						
R113	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R114	Composition	1.8 k Ω $\pm$ 5% 1/4 W	6099-2185	75042	BTS, 1.8 k Ω $\pm$ 5%	5905-688-3738
R115	Composition	680 Ω $\pm$ 5% 1/4 W	6099-1685	75042	BTS, 680 Ω $\pm$ 5%	
R116	Composition	100 Ω $\pm$ 10% 1/4 W	6099-1109	75042	BTS, 100 Ω $\pm$ 10%	
R117	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R118	Composition	68 k Ω $\pm$ 5% 1/4 W	6099-3685	75042	BTS, 68 k Ω $\pm$ 5%	5905-681-8853
R119	Composition	390 k Ω $\pm$ 5% 1/4 W	6099-4395	75042	BTS, 390 k Ω $\pm$ 5%	
R120	Composition	180 Ω $\pm$ 10% 1/4 W	6099-1189	75042	BTS, 180 Ω $\pm$ 10%	
R121	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R122	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R123	Composition	10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R124	Composition	10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R125	Composition	390 Ω $\pm$ 5% 1/4 W	6099-1395	75042	BTS, 390 Ω $\pm$ 5%	
R126	Composition	390 Ω $\pm$ 5% 1/4 W	6099-1395	75042	BTS, 390 Ω $\pm$ 5%	
R127	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R128	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R129	Composition	2.7 k Ω $\pm$ 5% 1/4 W	6099-2275	75042	BTS, 2.7 k Ω $\pm$ 5%	
R130	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R131	Composition	39 k Ω $\pm$ 5% 1/4 W	6099-3395	75042	BTS, 39 k Ω $\pm$ 5%	5905-686-3358
R132	Composition	68 k Ω $\pm$ 5% 1/4 W	6099-3685	75042	BTS, 68 k Ω $\pm$ 5%	5905-681-8853
R133	Composition	15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R134	Composition	15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R135	Composition	10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R136	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R141	Composition	47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R142	Composition	10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R143	Composition	20 k Ω $\pm$ 5% 1/4 W	6099-3205	75042	BTS, 20 k Ω $\pm$ 5%	5905-686-3368
R144	Composition	510 Ω $\pm$ 5% 1/4 W	6099-1515	75042	Bts, 510 Ω $\pm$ 5%	5905-801-8272
R145	Pot. Comp.	100 Ω $\pm$ 20%	6040-0100	01121	FWC, 100 Ω $\pm$ 20%	
R146	Composition	470 Ω $\pm$ 5% 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm$ 5%	5905-683-2246
R147	Composition	240 Ω $\pm$ 5% 1/4 W	6099-1245	75042	BTS, 240 Ω $\pm$ 5%	
R148	Composition	47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R149	Composition	10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R150	Composition	22 k Ω $\pm$ 5% 1/4 W	6099-3225	75042	BTS, 22 k Ω $\pm$ 5%	5905-687-0002
R151	Composition	3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	5905-681-9969
R152	Composition	47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R153	Composition	4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9998
R154	Composition	18 k Ω $\pm$ 5% 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm$ 5%	5905-687-0000
R155	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R156	Composition	47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R157	Composition	10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R158	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R159	Composition	22 Ω $\pm$ 5% 1/4 W	6099-3225	75042	BTS, 22 k Ω $\pm$ 5%	5905-687-0002
R160	Composition	360 Ω $\pm$ 5% 1/4 W	6099-1365	75042	BTS, 360 Ω $\pm$ 5%	
R161	Composition	6.8 k Ω $\pm$ 5% 1/4 W	6099-2685	75042	BTS, 6.8 k Ω $\pm$ 5%	5905-686-9997
R162	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R163	Composition	2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R164	Composition	6.8 k Ω $\pm$ 5% 1/4 W	6099-2685	75042	BTS, 6.8 k Ω $\pm$ 5%	5905-686-9997
R165	Composition	270 Ω $\pm$ 5% 1/4 W	6099-1275	75042	BTS, 270 Ω $\pm$ 5%	
R166	Composition	47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R167	Composition	1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R168	Composition	100 k Ω $\pm$ 10% 1/4 W	6099-4109	75042	BTS, 100 k Ω $\pm$ 10%	
R169	Composition	22 k Ω $\pm$ 5% 1/4 W	6099-3225	75042	BTS, 22 k Ω $\pm$ 5%	5905-687-0000



NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

- NOTE UNLESS SPECIFIED
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
 2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
 3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
 4. RESISTORS 1/4 WATT.
 5. RESISTANCE IN OHMS $\times 1000$ OHMS $M = 1$ MEGOHM
 6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
 7. KNOB CONTROL
 8. SCREWDRIVER CONTROL
 9. AT - ANCHOR TERMINAL
 10. TP - TEST POINT



TRANSISTORS - BOTTOM VIEW

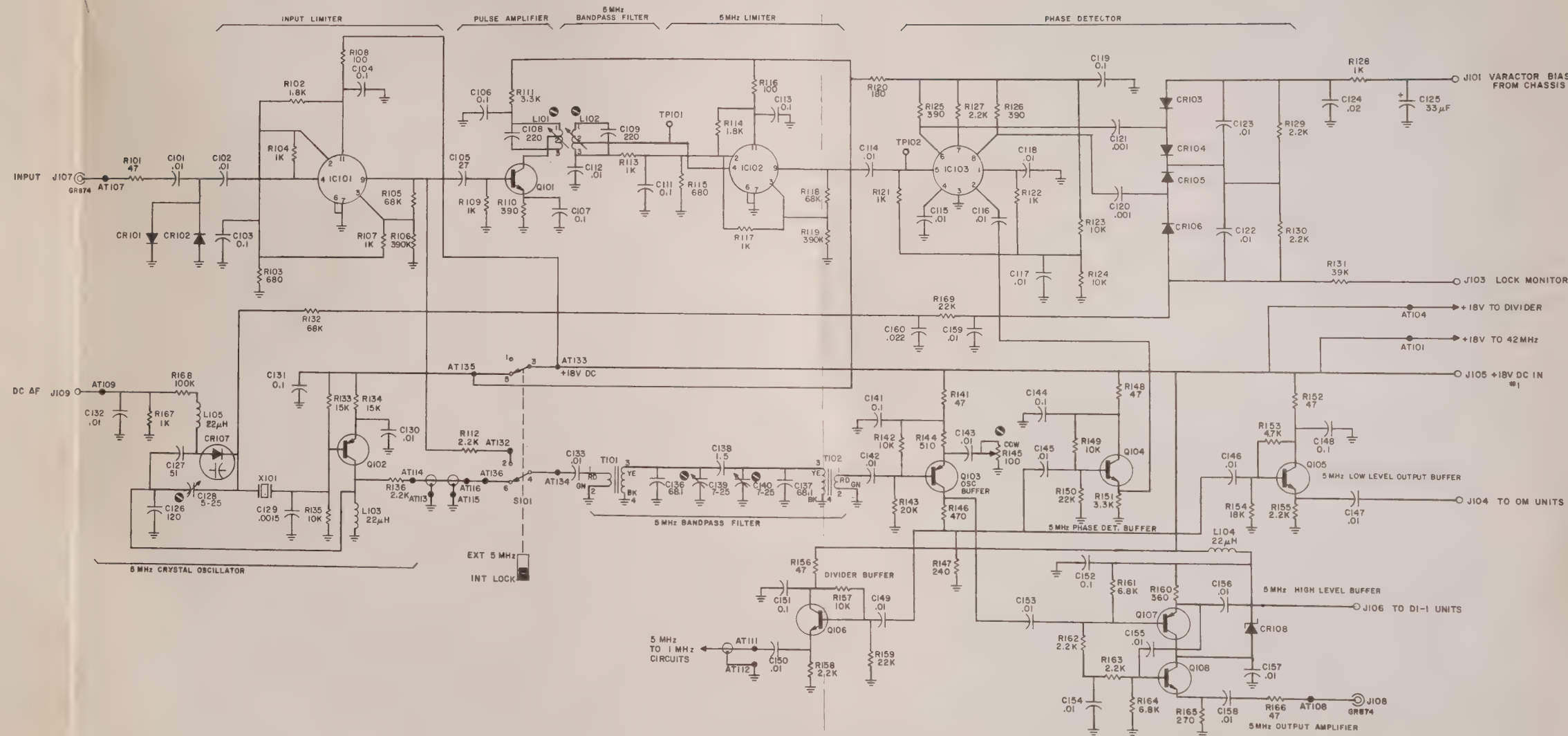


Figure CB-10. Schematic and etched-board diagrams for Master Frequency Section

ELECTRICAL PARTS LIST

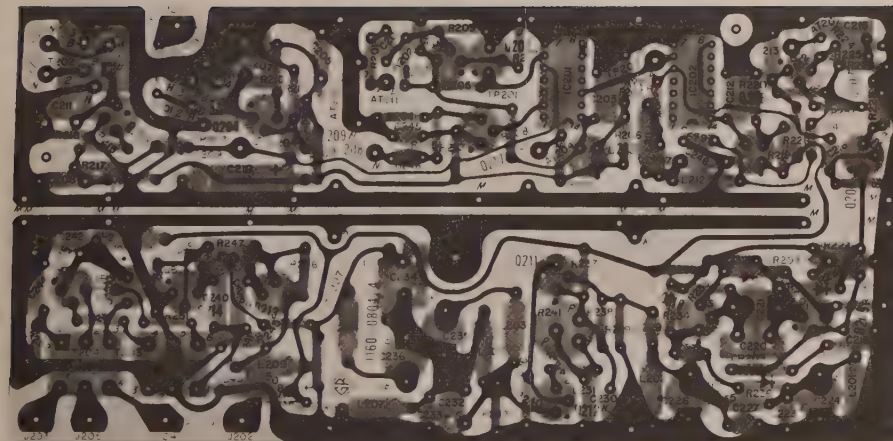
Ref. No.	Name	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. Code	Fed. Stock No.
CAPACITORS						
C201	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C202	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C203	Ceramic	1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C204	Ceramic	150 pF ±10% 500 V	4404-1158			
C205	Ceramic	0.1 µF +80-20% 50 V	4403-4100	80131	CC63, .1 µF +80-20%	5910-811-4788
C207	Mica	1200 pF ±5% 100 V	4700-0685	14655	22A, 1200 pF ±5%	
C208	Ceramic	0.1 µF +80-20% 50 V	4403-4100	80131	CC63, .1 µF +80-20%	5910-811-4788
C209	Ceramic	150 pF ±10% 500 V	4404-1158	72982	831, 150 pF ±10%	
C210	Electrolytic	150 µF ±20% 20 V	4450-5723	90201	210000331100107	
C211	Mica	1200 pF ±5% 100 V	4700-0685	14655	22A, 1200 pF ±5%	
C212	Ceramic	1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C213	Ceramic	0.1 µF +80-20% 50 V	4403-4100	80131	CC63, 0.1 µF +80-20%	5910-811-4788
C214	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C215	Ceramic	1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C216	Ceramic	15 pF N30 ±5% 500 V	4411-0155	72982	801, 15 pF N30 ±5%	
C217	Ceramic	0.1 µF +80-20% 50 V	4403-4100	80131	CC63, 0.1 µF +80-20%	5910-811-4788
C218	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C219	Ceramic	270 pF ±10% 500 V	4404-1278	72982	831, 270 pF ±10%	
C220	Trimmer	121 pF 500 V	4910-0031	24655	4910-0031	
C221	Trimmer	7 - 25 pF N300 350 V	4910-2043	72982	538-002, 7 to 25 pF N300	
C222	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C223	Ceramic	120 pF ±5% 500 V	4404-1125	72982	831, 120 pF ±5%	
C224	Trimmer	7 - 25 pF N300 350 V	4910-2043	72982	538-002, 7 to 25 pF N300	
C226	Trimmer	7 - 25 pF N300 350 V	4910-2043	72982	538-002, 7 to 25 pF N300	
C227	Ceramic	75 pF N30 ±5% 500 V	4411-0753	56289	29C444	
C228	Ceramic	120 pF ±5% 500 V	4404-1125	72982	831, 120 pF ±5%	
C229	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C230	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C231	Ceramic	1.0 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C232	Mica	90.9 pF ±2% 500 V	4700-0390	14655	22A, 90.9 pF ±2%	
C233	Ceramic	150 pF ±5% 500 V	4404-1155	72982	831, 120 pF ±5%	
C234	Mica	90.9 pF ±2% 500 V	4700-0390	14655	22A, 90.9 pF ±2%	
C235	Trimmer	7 - 25 pF N300 350 V	4910-2043	72982	538-002, 7 to 25 pF N300	
C236	Trimmer	7 - 25 pF N300 350 V	4910-2043	72982	538-002, 7 to 25 pF N300	
C237	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C238	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C239	Ceramic	1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C240	Ceramic	1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C241	Ceramic	1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C242	Ceramic	2.2 µF ±20% 25 V	4400-2080	80183	5C13, 2.2 µF ±20%	
C243	Electrolytic	2.2 µF ±20% 20 V	4450-4500	56289	150D225X0020A2	5910-976-4604
C244	Ceramic	2.2 µF ±20% 25 V	4400-2080	80183	5C13, 2.2 µF ±20%	
C245	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C246	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C247	Ceramic	270 pF ±10% 500 V	4404-1278	72982	831, 270 pF ±10%	
C248	Ceramic	.0022 µF ±5% 500 V	4406-2225	72982	811, .0022 µF ±5%	5910-899-0668
C249	Ceramic	.001 µF ±10% 500 V	4405-2108	72982	801, .001 µF ±10%	5910-914-0087
RESISTORS						
R201	Composition	47 Ω ±10% 1/4 W	6099-0479	75042	BTS, 47 Ω ±10%	
R202	Composition	2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%	5905-723-5251
R203	Composition	12 kΩ ±5% 1/4 W	6099-3125	75042	BTS, 12 kΩ ±5%	
R204	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R205	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R206	Film	3.65 kΩ ±1% 1/8 W	6250-1365	75042	CEA, 3.65 kΩ ±1%	
R207	Film	1.78 kΩ ±1% 1/8 W	6250-1178	75042	CEA, 1.78 kΩ ±1%	5905-824-3077
R208	Composition	330 Ω ±10% 1/4 W	6099-1339	75042	BTS, 330 Ω ±10%	
R209	Composition	47 Ω ±10% 1/4 W	6099-0479	75042	BTS, 47 Ω ±10%	
R210	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±10%	5905-681-6462
R212	Composition	10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R213	Composition	22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R214	Composition	47 Ω ±10% 1/4 W	6099-0479	75042	BTS, 47 Ω ±10%	
R215	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R216	Composition	10 Ω ±10% 1/4 W	6099-0109	75042	BTS, 10 Ω ±10%	
R217	Composition	10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R218	Composition	22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R219	Film	3.65 kΩ ±1% 1/8 W	6250-1365	75042	CEA, 3.65 kΩ ±1%	
R220	Film	1.78 kΩ ±1% 1/8 W	6250-1178	75042	CEA, 1.78 kΩ ±1%	5905-824-3077
R221	Composition	100 Ω ±10% 1/4 W	6099-1109	75042	BTS, 100 Ω ±10%	
R222	Composition	10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R223	Composition	33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R224	Composition	620 Ω ±5% 1/4 W	6099-1625	75042	BTS, 620 Ω ±5%	5905-801-6998
R225	Composition	47 Ω ±10% 1/4 W	6099-0479	75042	BTS, 47 Ω ±10%	

ELECTRICAL PARTS LIST (cont)

Ref. No.	Name	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. Code	Fed. Stock No.
RESISTORS						
R226	Composition	6.8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6.8 kΩ ±5%	5905-686-9997
R227	Composition	820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R228	Composition	330 Ω ±10% 1/4 W	6099-1339	75042	BTS, 330 Ω ±10%	
R229	Composition	15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R230	Composition	4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R231	Composition	180 Ω ±5% 1/4 W	6099-1185	75042	BTS, 180 Ω ±5%	5905-279-5476
R232	Composition	560 Ω ±5% 1/4 W	6099-1565	75042	BTS, 560 Ω ±5%	
R233	Composition	5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R234	Composition	470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R235	Composition	47 Ω ±10% 1/4 W	6099-0479	75042	BTS, 47 Ω ±10%	
R236	Composition	2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%	5905-723-5251
R237	Composition	47 Ω ±10% 1/4 W	6099-0479	75042	BTS, 47 Ω ±10%	
R238	Composition	3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R239	Composition	12 kΩ ±5% 1/4 W	6099-3125	75042	BTS, 12 kΩ ±5%	
R240	Composition	8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R241	Por. Comp.	250 Ω ±20%	6040-0200	01121	FWC, 250 Ω ±20%	5905-072-7723
R242	Composition	15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 15 Ω ±5%	
R243	Composition	1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R244	Composition	1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R245	Composition	220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R246	Composition	3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R247	Composition	680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R248	Composition	3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R249	Composition	68 Ω ±5% 1/4 W	6099-0685	75042	BTS, 68 Ω ±5%	
R250	Composition	10 Ω ±10% 1/4 W	6099-0109	75042	BTS, 10 Ω ±10%	
R251	Composition	10 Ω ±10% 1/4 W	6099-0109	75042	BTS, 10 Ω ±10%	
R252	Composition	4.7 Ω ±5% 1/4 W	6099-9475	75042	BTS, 4.7 kΩ ±5%	
R253	Composition	470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R254	Composition	330 Ω ±10% 1/4 W	6099-1339	75042	BTS, 330 Ω ±5%	
R255	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R256	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R257	Composition	100 Ω ±10% 1/4 W	6099-1109	75042	BTS, 100 Ω ±10%	
TRANSISTORS						
Q201	Type	2N4258	8210-1136	93916	2N4258	
Q202	Type	2N4275	8210-1126	23342	2N4275	
Q203	Type	2N697	8210-1040	82219	2N697	5961-752-0150
Q204	Type	2N3905	8210-1114	04713	2N3905	
Q205	Type	2N3905	8210-1114	04713	2N3905	
Q206	Type	2N697	8210-1040	82219	2N697	5961-752-0150
Q207	Type	2N3903	8210-1132	93916	2N3903	
Q208	Type	2N4275	8210-1126	23342	2N4275	
Q209	Type	2N4275	8210-1126	23342	2N4275	
Q210	Type	2N4275	8210-1126	23342	2N4275	
Q211	Type	2N3414	8210-1047	24446	2N3416	5961-989-2749
Q212	Type	2N3905	8210-1114	04713	2N3905	
Q213	Type	2N3903	8210-1132	93916	2N3903	
Q214	Type	2N3905	8210-1114	04713	2N3905	
Q215	Type	2N5189	8210-1163	06111	2N4258	
Q216	Type	2N5189	8210-1163	06111	2N4258	
Q217	Type	2N3903	8210-1132	93916	2N3903	
MISCELLANEOUS						
CR201	Type	1N3604	6082-1001	24446	1N3604	5961-995-2199
CR202	Type	1N3604	6082-1001	24446	1N3604	5961-995-2199
CR203	Type	1N3604	6082-1001	24446	1N3604	5961-995-2199
MISCELLANEOUS						
L201	Choke, Molded	12.1 µH ±2%	4300-2310	99800	1833-138	
L202	Choke, Molded	12.1 µH ±2%	4300-2310	99800	1833-138	
L203	Choke, Molded	100 µH ±2%	4300-2690	99800	1833-76	
L204	Choke, Molded	100 µH ±2%	4300-2690	99800	1833-76	
L205	Choke, Molded	23.7 µH ±2%	4300-2630	99800	1833-146	
L206	Choke, Molded	23.7 µH ±2%	4300-2630	99800	1833-146	
L207	Choke, Molded	14.7 µH ±2%	4300-2370	99800	1833-140	
L209	Choke, Molded	5.6 µH ±10%	4300-1800	99800	1537-30, 5.6 µH ±10%	
L210	Choke, Molded	5.6 µH ±10%	4300-1800	99800	1537-30, 5.6 µH ±10%	
L211	Choke, Molded	1000 µH ±10%	4300-6383	72259	07-51003-000	
L212	Choke, Molded	2200 µH ±10%	4300-6388	72259	52202000	

ELECTRICAL PARTS LIST (cont)

Ref. No.	Name	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. Code	Fed. Stock No.
MISCELLANEOUS						
T201	Transformer		1160-0470	24655	1160-0470	
T202	Transformer		1160-0470	24655	1160-0470	
T203	Transformer, adjustable ferrite cup		5000-2816	24655	5000-2816	
T204	Transformer, adjustable, ferrite cup		5000-2818	24655	5000-2818	
IC201	N828A Digital		5431-9604	18324	N8280A	
IC202	N8280A Digital		5431-9604	18324	N8280A	
J201	Etched-circuit, eyelet type		1160-6110	24655	1160-6110	
J202	Etchec-circuit, eyelet type		1160-6110	24655	1160-6110	
J203	Etched-circuit, eyelet type		1160-6110	24655	1160-6110	
J204	Etched-circuit, eyelet type		1160-6110	24655	1160-6110	
J205	Etched-circuit, eyelet type		1160-6110	24655	1160-6110	
J206	Multiple Socket, 100 KHz		4230-2300	81349	UG-1094/U	5935-853-759
J208	Multiple Socket, 1MHz		4230-2300	81349	UG-1094/U	5935-853-759



NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

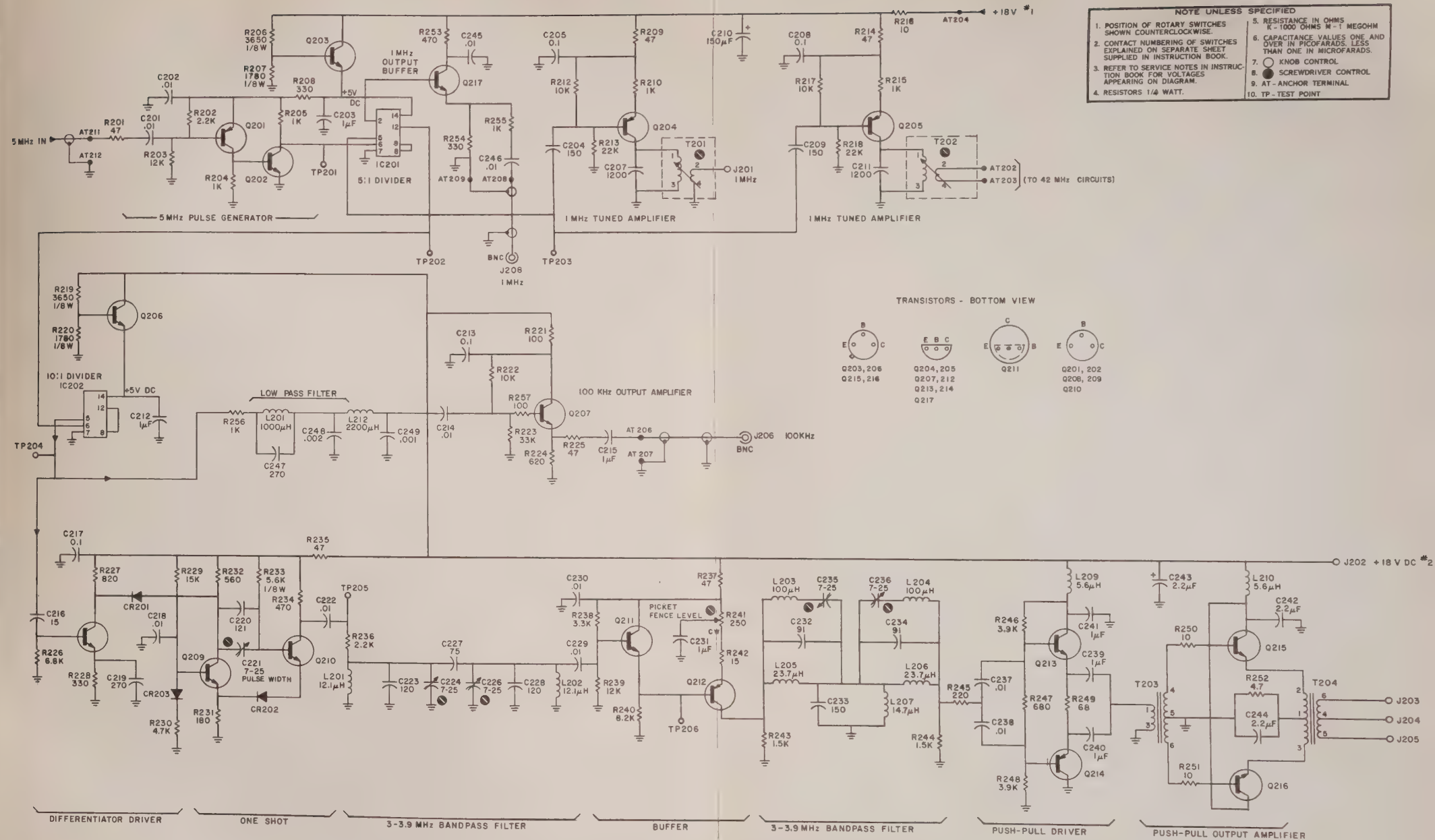


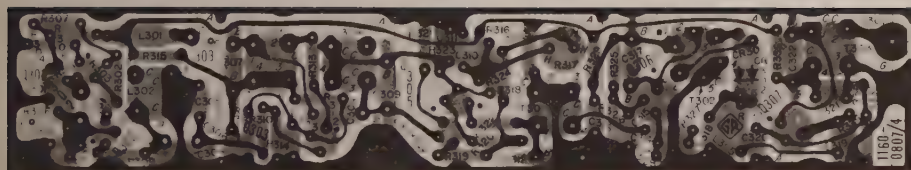
Figure CB-11. Schematic and etched-board diagrams for Picket-Fence Section.

ELECTRICAL PARTS LIST

Ref. No.	Name	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. Code	Fed. Stock No.
CAPACITORS						
C301	Ceramic	.01 µF +80-20 % 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C302	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C303	Ceramic	.02 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C304	Mica	120 pF ±10% 500 V	4700-0425	14655	22A, 120 pF ±10%	
C305	Ceramic	.001 µF ±5% 500 V	440S-2105	72982	801, .001 µF ±5%	
C306	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C307	Ceramic	100 pF N30 ±5% 500 V	4411-1105	56289	33C181	
C308	Ceramic	1.2 pF ±10% 500 V	4400-0129	24655	4400-0129	
C309	Ceramic	100 pF N30 ±5% 500 V	4411-1105	56289	33C181	
C310	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C311	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C312	Ceramic	150 pF N030 ±5% 200 V	4400-6254	72982	855, 150 pF ±5%	
C314	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C315	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C316	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C317	Ceramic	91 pF N30 ±5% 500 V	4411-0915	72982	81101B1G0620J	
C318	Ceramic	15 pF N30 ±5% 500 V	4411-0155	72982	801, 15 pF N30 ±5%	
C319	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C320	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C321	Ceramic	.01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C322	Ceramic	91 pF N30 ±5% 500 V	4411-0915	72982	811001B1G0620J	
C323	Ceramic	1 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
RESISTORS						
R301	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R302	Composition	33 Ω ±10% 1/4 W	6099-0339	75042	BTS, 33 Ω ±10%	
R303	Composition	33 Ω ±10% 1/4 W	6099-0339	75042	BTS, 33 Ω ±10%	
R304	Composition	330 Ω ±10% 1/4 W	6099-1339	75042	BTS, 330 Ω ±10%	
R305	Composition	22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R306	Composition	10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R307	Composition	470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R308	Composition	100 Ω ±10% 1/4 W	6099-1109	75042	BTS, 100 Ω ±10%	
R309	Composition	330 Ω ±10% 1/4 W	6099-1339	75042	BTS, 330 Ω ±10%	
R310	Composition	47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R311	Composition	3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R312	Composition	5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R313	Composition	220 Ω ±10% 1/4 W	6099-1229	75042	BTS, 220 Ω ±10%	
R314	Composition	1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R315	Composition	100 Ω ±10% 1/4 W	6099-1109	75042	BTS, 100 Ω ±10%	
R316	Composition	100 Ω ±10% 1/4 W	6099-1109	75042	BTS, 100 Ω ±10%	
R317	Pot. Comp.	1 kΩ ±10%	6049-0215	01121	SV1021	
R318	Composition	470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R319	Composition	33 Ω ±10% 1/4 W	6099-0339	75042	BTS, 33 Ω ±10%	
R320	Composition	33 Ω ±10% 1/4 W	6099-0339	75042	BTS, 33 Ω ±10%	
R321	Composition	330 Ω ±10% 1/4 W	6099-1339	75042	BTS, 330 Ω ±10%	
R322	Composition	330 Ω ±10% 1/4 W	6099-1339	75042	BTS, 330 Ω ±10%	
R323	Composition	22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R324	Composition	10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R325	Composition	5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R326	Composition	3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R327	Composition	100 Ω ±10% 1/4 W	6099-1109	75042	BTS, 100 Ω ±10%	
R328	Composition	820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R329	Composition	47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R331	Composition	5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R332	Composition	3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R333	Composition	47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R334	Composition	820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R335	Composition	47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
MISCELLANEOUS						
Q301	Type	2N3905	8210-1114	04713	2N3905	
Q302	Type	2N3905	8210-1114	04713	2N3905	
Q303	Type	2N3903	8210-1132	93916	2N3903	
Q304	Type	2N3905	8210-1114	04713	2N3905	
Q305	Type	2N3905	8210-1114	04713	2N3905	
Q306	Type	2N3903	8210-1132	93916	2N3903	
Q307	Type	2N3903	8210-1132	93916	2N3903	

ELECTRICAL PARTS LIST (cont)

Ref. No.	Name	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. Code	Fed. Stock No.
MISCELLANEOUS						
CR301	Type	1N3604	6082-1001	24446	1N3604	5961-995-2199
CR302	Type	1N3604	6082-1001	24446	1N3604	5961-995-2199
L301	Choke, Molded	22 µH ±10%	4300-2600	99800	1537, 22 µH ±10%	5950-668-5867
L302	Inductor, Asm.		1160-2415	24655	1160-2415	
L303	Inductor, Asm.		1160-2415	24655	1160-2415	
L304	Inductor, Asm.		1160-2415	24655	1160-2415	
L305	Choke, Molded	1 µH ±10%	4300-0700	99800	1537, 1 µH ±10%	5950-683-7984
T301	Transformer Asm.		1160-2425	24655	1160-2425	
T302	Transformer Asm.		1160-2435	24655	1160-2435	
T303	Transformer Asm.		1160-2442	24655	1160-2442	
J301	Etched-circuit, eyelet type		1160-6110	24655	1160-6110	
—	Assembly, etched Board, MASTER FREQUENCY		1160-2803	24655	1160-2803	
—	Assembly, etched Board, PICKET FENCE		1160-2806	24655	1160-2806	
—	Assembly, etched Board, 42 MHz circuit		1160-2809	24655	1160-2809	



NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

- NOTE UNLESS SPECIFIED
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
 2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
 3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
 4. RESISTORS 1/4 WATT.
 5. RESISTANCE IN OHMS
K = 1000 OHMS M = 1 MEGOHM
 6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
 7. ○ KNOB CONTROL.
 8. ● SCREWDRIVER CONTROL.
 9. AT - ANCHOR TERMINAL.
 10. TP - TEST POINT.

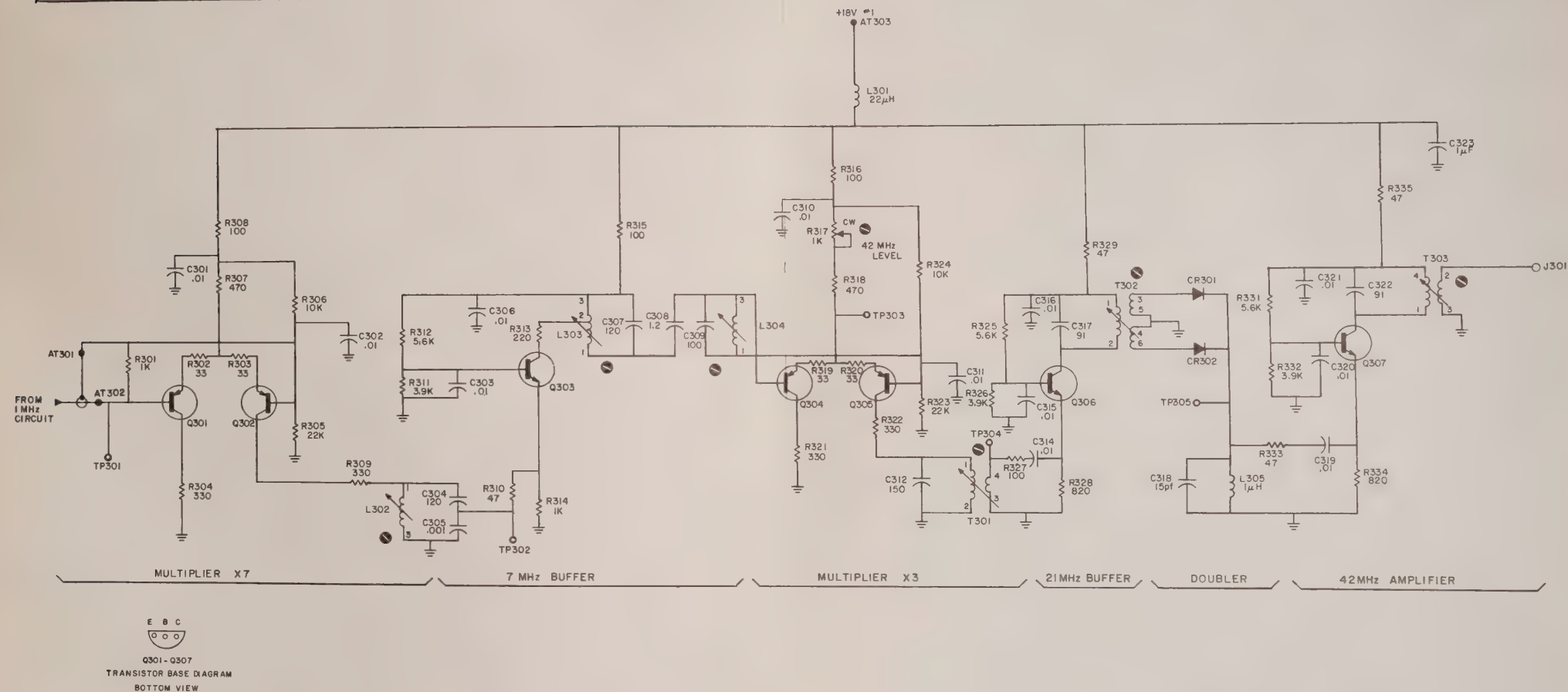


Figure CB-12. Schematic and etched-board diagram for the 42-MHz Section.

section **DC**

DIGIT - INSERTION UNIT - DI-4

P/N 1163-4000

(Used only in the Type 1163 Synthesizers)

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GENERAL RADIO COMPANY

West Concord, Massachusetts

SECTION DC-1

INTRODUCTION

DC-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared with a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension, by experienced service personnel, of the principles of operation. A trouble-analysis procedure that will aid in isolating the defective circuit completes the section.

To facilitate part identification, reference designators used in the text and on the photographs are the same as those that appear on the complete schematic diagram and in the parts list. The reference designators are silk-screened on the module as a further aid in part location.

The service instructions are written to facilitate use of a properly functioning synthesizer as a basic test frame for the module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the widespread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

DC-1.2 PURPOSE.

The DI-4 Digit-Insertion unit is employed in the General Radio Type 1163 12-Mc Coherent Decade-Frequency Synthesizer to furnish the dial-selected 1-Mc steps in the instrument output. It differs completely in function and electrical design from other Digit-Insertion units in the instrument and, although of a very similar mechanical configuration, is not interchangeable with other types of Digit-Insertion units. Mounting arrangements in the chassis are identical with those for the other digit units, comprised of two screws through the front panel to the top of the unit and a hold-down clamp at the rear. (For a description of the DI-1 module, the digit unit repetitively used for all steps in the Type 1161 and 1162 synthesizers, and for all steps but $\times 1$ Mc/s in the Type 1163, refer to Section DA of this manual.)

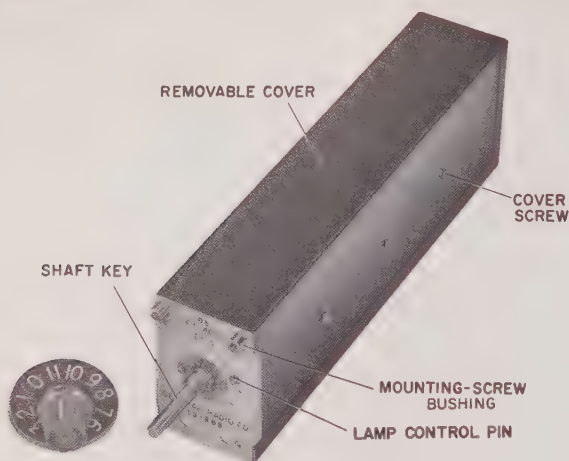


Figure DC-1.
DI-4 Digit-Insertion unit module.

DC-1.3 DESCRIPTION.

DC-1.3.1 MECHANICAL LAYOUT.

The mechanical layout of the DI-4 module is very similar to that of the DI-1 unit and consists of an assembly of four etched boards, which contains all of the electrical components that form the DI-4 circuitry.

Sheet-metal rails, on the long edges of the two larger circuit boards, run the length of the unit. Threaded inserts on these rails fasten the entire assembly. A central sheet-metal shield provides electrical isolation and additional mechanical support for the structure. Spool inserts in the edge of this shield plate serve as anchor points for the module cover.

The front of the unit consists of an etched-circuit board and structural parts. This front etched-circuit board carries the dial-lamp control circuitry. A pin on the board projects through the front of the module (see Figure DC-1) to establish electrical contact with the DI-4 dial-lamp control spring on the chassis front panel. A plate in front of this etched board carries the digit-selector switch detent mechanism. Spring contacts of finger stock around the perimeter of the front panel make a tight electrical seal with the mouth of the outer cover.

The rear of the module consists of a vertical etched board which carries the Digit Oscillator (see paragraph DC-2.3) and the rotary switch wafers operated by the front-panel control. The switch wafers and twelve tuning coils are mounted on a separate plate, on posts from the vertical etched board, that are positioned in such a way that the oscillator tuning adjustments are all accessible from the rear.

CAUTION

These are not intended for field adjustment.

The switch shaft runs the entire length of the module, just above the center shield partition.

The bottom board of the assembly carries three jacks and two ground-pickup pins, which engage contacts and banana plugs projecting from the sandwich deck.

A removable sheet-metal cover, which slides over the back of the unit, encloses the module on five sides. The cover is secured with six 4-40 screws, three per side. The cover, in addition to mechanical support and protection, provides electrical shielding for the more sensitive circuits in the module. Alignment of the unit is affected considerably by the presence or absence of this cover; consequently, the cover must be in place if the module is to function properly.

Interconnection between the etched boards is made, with two exceptions, by connection of wire links at the edges of the boards. The two exceptions are a twisted pair of wires (from top to bottom) at the front of the unit and the miniature coaxial cable, near the center, that passes through a hole in the center shield partition.

DC-1.3.2 ELECTRICAL CHARACTERISTICS.

Circuits are divided functionally at the circuit-board level, making component locations largely self-explanatory.

The DI-4 unit supplies signal outputs, frequency coherent with the master quartz oscillator in the AFS unit, necessary to produce the 1-Mc digit steps in the Type 1163 synthesizer. The function of this module in the operation of the Type 1163 system, described more fully in Section 4 of the front portion of this manual, consists of the subtraction (from the multiplied output of the DI-1 units (at 50-51 Mc/s), of frequencies in 1-Mc steps from 50 to 39 Mc/s, to obtain the 0-12-Mc output frequency. Table DC-1 gives the output frequency from the Type 1163 for each of the dial settings available.

To form the 12 frequency steps (50 to 39-Mc steps) coherently from the master crystal oscillator, the DI-4 accepts as an input, a 1-Mc sine-wave from the sandwich deck. The 1-Mc signal is generated in the AFS unit, by frequency division from the 5-Mc crystal oscillator (refer to Section CA of this manual). This 1-Mc input to the DI-4 is used as the reference to phase-lock an oscillator, which has been rough-tuned by the dial switch, to any one of the desired 50 to 39-Mc output frequencies of the DI-4. This principle is discussed more fully in Section DC-2.

The other external connections for the DI-4 consist of the +18-volt No. 1 input from the power supply and the external lamp-control pin. The lamp-control circuit is so arranged that, if the digit oscillator fails to lock, the lamp-control pin is de-energized and extinguishes the lamp in the lamp-control assembly on the front panel, to give warning of failure.

SECTION DC-2

PRINCIPLES OF OPERATION

DC-2.1 GENERAL

In this section, reference is made to the elementary schematic diagram, Figure DC-2, and the complete schematic diagram, Figure DC-14.

The principal circuit in the DI-4 is a sampled-data, automatic phase-control system which uses 1 Mc/s as a reference signal to lock a rough-tuned oscillator to a multiple of 1 Mc/s, chosen in the band of frequencies from 39 to 50 Mc/s.

The 1-Mc sine-wave input is converted to a short-duration, high-peak-power pulse with a 1-Mc repetition rate. This pulse is used to operate a gate connected to the output of the digit oscillator which, when opened by the pulse, connects the output of the oscillator to a holding capacitor that stores the in-

stantaneous value of the oscillator output voltage when the sampling pulse occurs. If the oscillator is tuned exactly to an integer multiple of the 1-Mc input, the value of the sample is the same each time and the voltage on the holding capacitor is dc. If there is a difference between the oscillator frequency and the corresponding multiple of the 1-Mc input reference, a stepwise sinewave signal results, which represents the drift between the oscillator and the closest multiple of the 1-Mc reference. The amplified holding-capacitor voltage is used as an error signal to phase-lock the oscillator. Figure DC-3 shows the nature of this error signal.

Since an ac component of error signal is present only when the oscillator is not locked, it can be used to indicate malfunction. In the DI-4, the error

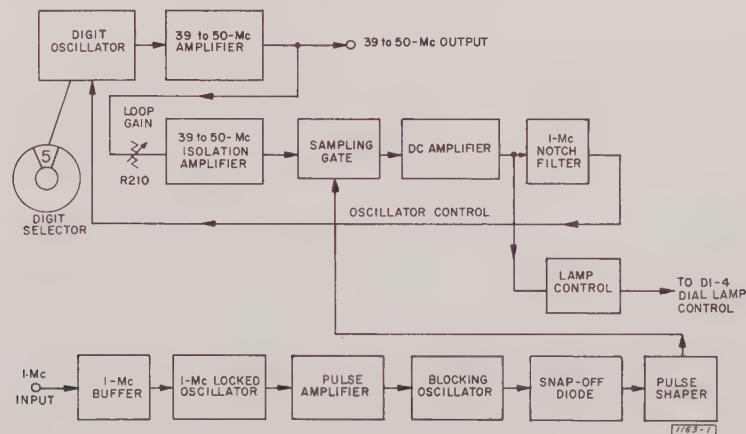
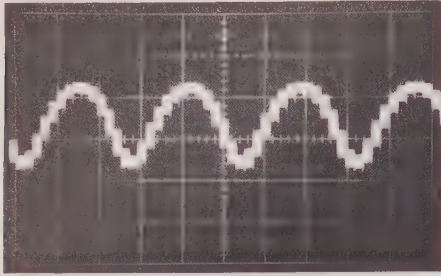


Figure DC-2. DI-4 Block diagram.



Base, Q101A

1160-6-27



0.05 V/cm 5.0 μ s/cm
Figure DC-3. Step-wise sinewave signal at the base of Q101A indicative of the operation of the sampler circuit in response to oscillator drift.

signal is sensed for presence of ac and, if ac is found, the dial lamp is extinguished (refer to paragraph DC-2.7).

The operating principles of individual circuits are discussed in more detail below.

DC-2.2 PULSE GENERATOR.

The 1-Mc input enters the DI-4 via J203. From this point, it is fed to a tuned isolation amplifier (Q204/T204) located at the front of the unit on the bottom board. The output link on T204 connects (via AT203 and AT204) to a 1-Mc injection-locked oscillator on the front of the top board.

This oscillator is comprised of Q103/Q104 and tuned-circuit elements C111, C112 and L106. The oscillator active element is an emitter-coupled transistor pair operating as a switch. In operation the transistors are turned on alternately, with a resulting square-wave of current in each collector. The tuned-circuit filters the square-wave current in the collector of Q103, and this voltage is tapped to the Q104 base, via C113, to close the loop on the oscillator.

The injected 1-Mc signal from T204 is fed in series with the base of Q103. The collector current of Q104 drives an inductor, L107. Inductor L107 rings at its self-resonant frequency for one-half cycle; CR105 clamps the next half cycle to dissipate the remainder of the energy in the inductor.

The resulting pulse is amplified in Q105 and another self-resonant choke, L108, shortens the spike further. This spike triggers the monostable blocking oscillator Q106/T102, and the blocking oscillator cycles once for each pulse received from Q105. The amplitude of the blocking oscillator is controlled by R128. Waveforms of these various parts of the circuit can be seen in Figure DC-6.

The load for the blocking oscillator consists of R127 and a snap-off diode, CR106, at the end of a coaxial delay line, Z101. When the blocking oscillator turns on negatively, CR106 turns on also, since its anode is effectively grounded for low frequencies, through delay lines Z102 and Z104. While it is conducting, a certain amount of charge is stored in the diode junction so that, when the blocking oscillator turns off abruptly, the diode retains its high conductance (because of the mobile carriers in its junction) until the charge is swept out. Then, as the stored charge is

abruptly exhausted, the diode turns off in a small fraction of a nanosecond.

This sharp transition creates a negative pulse at the anode of CR106, which propagates down Z102 until it reaches the junction of Z102, Z103, and Z104. The reflection of this pulse, from the end of shorted clipping line Z104, returns to the junction of the three delay lines with reversed phase, canceling the input. The electrical length of Z104 thus determines the width of the pulse. The pulse travels down Z103 to the sampling gate.

Delay lines Z101 to Z104 consist of the four sections of preformed, semirigid, 50-ohm coaxial cable mounted on the top board.

DC-2.3 DIGIT OSCILLATOR.

The Digit Oscillator assembly is mounted at the rear of the DI-4 module. The circuit contains one transistor, Q401, connected as a Colpitts oscillator with the base at rf ground.

Manual tuning is accomplished by switch selection of one of the 12 preset coils, L403 to L414. The

TABLE DC-1
TYPE 1163 SYNTHESIZER OUTPUT-FREQUENCY
RANGES FOR DI-4 DIAL SETTINGS
(Figure DC-5 and DC-14)

Synthesizer Range (Mc/s)	DI-4 Dial Setting	DI-4 f_{out} (Mc/s)	DI-4 Switch Position(S401)	Tuned by Coil
0-1	0	50	110F 210F	L403
1-2	1	49	111F 211F	L404
2-3	2	48	112F 212F	L405
3-4	3	47	101F 201F	L406
4-5	4	46	102F 202F	L407
5-6	5	45	103F 203F	L408
6-7	6	44	104F 204F	L409
7-8	7	43	105F 205F	L410
8-9	8	42	106F 206F	L411
9-10	9	41	107F 207F	L412
10-11	10	40	108F 208F	L413
11-12	11	39	109F 209F	L414

appropriate coil is selected by S401, the only operating control on the module. The 12 coils are tuned to the frequencies shown on Table DC-1. The 2-section 12-position rotary switch and the 12 coils surrounding it are mounted on the aluminum plate at the rear of the module.

The oscillator is also voltage-tunable (at AT404) by means of a dc voltage applied to varactor diodes CR401 and CR402. These diodes are in parallel for dc, since their cathodes are tied directly together and both anodes are grounded, one directly, the other through the oscillator coil. For the rf signal, however, the diodes are in series, since the rf appears across the oscillator coil; the voltage-variable capacitance represented by the two varactors in series is also across the oscillator coil and thus across the oscillating circuit.

As the dc voltage from AT404 to ground changes, the oscillator frequency changes correspondingly due to the action of the varactors. Dc power (+18 volts) enters this assembly at AT401, and a through connection feeds this B+ to the remainder of the DI-4 circuits, via AT405.

The rf output from the Digit Oscillator is taken from T401 a 3:1 stepdown, wide-band, toroid transformer in the collector circuit of Q401. This voltage is brought out to the bottom of the oscillator-circuit assembly at AT403 and is fed to the bottom board, where it drives the two high-frequency rf amplifiers described in paragraph DC-2.4.

DC-2.4 AMPLIFIER CIRCUIT.

The bottom board contains three amplifiers, one at 1-Mc, and two at the digit-oscillator frequency. The 1-Mc input amplifier, Q204, is a common-emitter amplifier with tuned output. It is driven by 1 Mc/s entering from the sandwich deck at J203. The tuned output transformer of this stage (T204), supplies 1 Mc/s to the top etched-circuit assembly via a twisted pair of leads from a coupling link on the coil connected to AT203 and AT204.

The second amplifier, Q203, is a broadband amplifier fed by the digit oscillator at AT205, that produces the signal required at the DI-4 output (J202). It also drives the isolation amplifier, Q202 and Q201, which feeds the phase-locking servo system.

The 39-to-50-Mc output leaves the DI-4 via J202 and a ground pin. A spring on the chassis picks up this ground pin when the DI-4 is inserted in its chassis. The Q203 amplifier is a common-base stage with 2:1 stepdown transformer output. The transformer is in transmission-line form, wound on a toroid to achieve broadband characteristics. The input and output impedance of the circuit are similar, and the amplifier has 6 dB of power gain. An adjustable input attenuator, R218, controls the drive to this stage and thereby the output signal level at J202.

The third amplifier on the bottom board consists of two stages, similar to the one described in the preceding paragraph, comprised of Q202 and Q201 and their associated transformers, T202 and T201. An attenuator pad with one adjustable arm regulates the drive to this two-stage amplifier from

the output of the Q203 amplifier. The purposes of this two-stage amplifier are to provide the drive signal to the sampler as part of the oscillator locking system, and to keep spurious frequency components, due to imbalances in the sampler, from appearing at the output jack. The ratio of forward-to-reverse gain of this stage is about 70 dB.

The output level of this amplifier determines the output level of the sampler; thus, adjustment of the drive to this stage from R210 controls the loop gain of the phase-lock servo system.

DC-2.5 SAMPLER AND DC AMPLIFIER SYSTEM.

DC-2.5.1 GENERAL.

The top board of the DI-4 contains the balance of the circuitry in the servo loop, including the pulse generator described in paragraph DC-2.2. The remainder of the circuits in the system include the sampler and dc control amplifier, described in the following paragraphs.

DC-2.5.2 SAMPLER.

The sampler is a normally closed gate circuit. This gate is "opened" on command from the 1-Mc repetition-rate pulse from the pulse generator described in paragraph DC-2.2. The gate remains open only for the duration of the pulse, 1 nanosecond. When the gate is open, the impedance between AT101 and the top of C105 is very low; otherwise it is very high.

The gating function is performed by the two high-speed sampling diodes, CR101 and CR102. The circuit is arranged so that the diodes are normally back biased by the voltage divider, R101, R102 and R103. A sampling pulse advancing down Z103 is converted by T103 to balanced drive for the sampler. The current in this pulse turns the diodes on through C101 and C102. The self-inductance of T101 prevents the transformer from short circuiting this very short-duration pulse. The digit-oscillator signal, however, fed in parallel to the windings of T101, appears directly on capacitors C101 and C102. Thus, when CR101 and CR102 conduct, the path through these diodes in parallel is the primary circuit between AT101 (the feedpoint for the rf) and C105, the sample-hold capacitor. C105 therefore charges very rapidly to the instantaneous rf level.

When the gate is closed, holding capacitor C105 is thus left with a charge proportional to the instantaneous level of the rf at AT101, at the time the last sample was taken. C105, when the gate is closed, is loaded only by a very high impedance determined by the Q101 bias current and the reverse leakage current through the diodes; it therefore discharges very slowly. The dc component of current in these two discharging loads is cancelled by a current fed to this point of the circuit by R104, a 10-M Ω resistor. This current is determined by the setting of R105, which is adjusted so that the value of the sample charge in C105 (and the voltage across C105) is retained with minimum change, until replaced by the next sample, 1 μ s later.



DC-2.5.3 DC AMPLIFIERS.

The dc amplifier in the servo loop consists of Q101, a differential-amplifier transistor pair in a single case, and Q102. The over-all voltage gain with feedback is about 3 and is designed for zero offset and minimum drift. This amplifier provides a low source impedance for the low-pass filter in the oscillator-control circuit, minimum loading on C105, and additional loop gain.

A 1-Mc notch filter (consisting of L104, C107 and L105, C108) is in series with the control line of the oscillator, so that any 1-Mc component appearing at the output of the dc amplifier does not appear at the digit-oscillator control input. Such a signal, if present, would create 1-Mc fm sidebands on the output of the DI-4.

DC-2.6 RECAPITULATION — OSCILLATOR CONTROL LOOP.

In the preceding paragraphs, the individual parts of the oscillator locking system have been described. These elements make up the oscillator locking scheme, to maintain the selected frequency outputs of the DI-4 at strict multiples of the incoming 1-Mc signal.

In review, the rf output of the digit oscillator is sampled at a 1-Mc rate controlled by the 1-Mc input. If the frequency of the digit oscillator is exactly 50 times the input signal (1-Mc), exactly 50 cycles of the 50 Mc/s will occur between samples and the value of the sample will be exactly the same each time. Its value will depend on the phase and amplitude of the 50-Mc signal. Likewise, if the rf is exactly 49 Mc/s, 49 cycles will occur between samples and the value at the instant each sampling pulse occurs will again be the same as at the previous one. The output of the sampler, since the sample is "held" by C105, will

therefore be dc, if the frequency is any exact multiple of the 1-Mc sampling rate. Thus, the sampling system can make no distinction as to which multiple is being observed, only that it is, in fact, a multiple of the sampling rate.

If however the rf is not exactly a multiple of the 1-Mc input, each sample will see a different phase of the rf than it saw previously and the result will be a stepwise sinewave with a frequency equal to the amount the rf differs from the closest multiple of 1 Mc/s. This statement holds regardless of which multiple is being dealt with (see Figure DC-3).

The output of the dc amplifier is connected to the digit-oscillator varactors, CR401 and CR402, (via AT108) and corrects the digit-oscillator frequency as required to establish the integral relationship of this frequency to 1 Mc/s, at a multiple as chosen by the position of switch S401.

DC-2.7 LAMP-CONTROL CIRCUIT.

This circuit is mounted on the front etched-circuit board of the DI-4 and functions to extinguish the pilot light in front of the DI-4, if the reference signal is present but the oscillator fails to lock. This function is accomplished by sensing for the presence of ac on the oscillator control line. If ac is present, this implies that either the oscillator is not locked or the phase-lock loop is self-oscillating, either condition being a malfunction. Ac amplifier Q301 will amplify any ac present on the oscillator control line. If any ac is present, it is detected by CR301 and CR302. This changes the bias on Q302, driving Q302 out of conduction. If this occurs, the voltage on the lamp-control pin drops to zero and the lamp-control transistor on the chassis lamp-panel assembly cuts off and extinguishes the lamp. (See Sections BA and BB on the chassis for discussion of the operation of these circuits.)

SECTION DC-3

SERVICE AND MAINTENANCE

DC-3.1 INTRODUCTION.

If the system fault-localization procedure of Section 5 of the front portion of the manual indicates possible malfunction of the DI-4 unit, the most positive verification of this suspicion is the substitution of another DI-4 unit.

NOTE

DI-1 and RDI-1 units may not be substituted for a DI-4

If this step restores the instrument to normal operation, the defective DI-4 should, if possible, be returned to the General Radio Company for service and repair, especially if it is within the two-year warranty.

Since there is but one DI-4 unit per Type 1163 synthesizer, and since service spares may not be available, it will not always be possible to make the substitution as outlined above. Where this is not possible,

selected tests and a few alignment steps may be made in the field. The synthesizer cannot operate without a properly functioning DI-4 module.

CAUTION

Most alignment procedures require the use of special test fixtures and cannot be accomplished in the field.

A thorough knowledge of the principles of operation, and all of the circuit arrangements by which the desired operation is achieved, is essential before DI-4 module service is attempted.

DC-3.2 TEST EQUIPMENT.

Recommended test equipment is listed and described in Table DC-2; equivalent equipment may be substituted.

TABLE DC-2
TEST EQUIPMENT

<u>Function</u>	<u>Type Recommended</u>	<u>Minimal Characteristics</u>
Electronic Voltmeter (VTVM)	GR 1806 with 1806-P1 probe	2% accuracy; ac and dc capabilities
Dual-Trace Oscilloscope	Tektronix 543 (with C/A plug-in and P6006 10x passive probe)	20 Mc/s, 0.5 V/cm with 8 pF (or less) probe capacitance
Alignment Tool	JFD No. 5284	Insulated soft-tip screwdriver
Sampling Oscilloscope	Tektronix 661 with 4S1 and 5T1A plug-in and P6032 CF probe	1000 Mc/s; high-impedance probe
Digital Counter	GR 1192-Z	Up to 50 Mc/s with 5-place readout
Standard Sweep Frequency Generator	GR 1025	Calibration accuracy - 0.5%

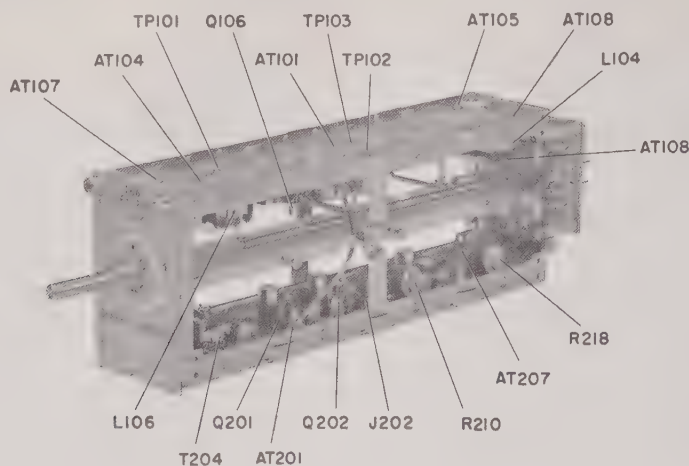


Figure DC-4. Interior of DI-4 module showing test points and secondary adjustment controls.

DC-3.3 TROUBLE ANALYSIS.

CAUTION

Turn power off during set-up changes to avoid accidental short circuits, which can blow F503 in the power-supply module, PS-1, (Section GA).

DC-3.3.1 GENERAL.

Remove the instrument from the cabinet, remove the DI-4 unit and the DI-1 unit in station II. For procedural details refer to Section 5.4.2 (in the front portion of the manual). Release the 6 screws in the sides and slide the cover off the DI-4. Reinstall the unit (less cover) in the chassis and install the spare DI-1 Bridging Unit (supplied) in station II.

Set the DI-4 digit dial to 5, set the DI-1 dials in any position and apply power to the synthesizer.

Refer to Figures DC-4 and DC-5 for the locations of test points and secondary adjustments referred to in procedures that follow. See also Figure DC-14, the over-all schematic diagram.

The most common symptoms of failure within the DI-4 will be the generation of improper frequencies or the failure to give any output whatever. Procedures that follow will give assurance that the difficulty is in the DI-4 module and not in some other unit and will facilitate fault isolation to the detail-part level.

DC-3.3.2 POWER INPUT.

With the VTVM, look for $+18 \pm 0.2$ Vdc at AT105 on the top circuit board. If the indication is abnormal, look at AT207 at the bottom circuit board of the DI-4. A level of approximately +17.5 Vdc should be found there and also at the collectors (cases) of Q201, Q202

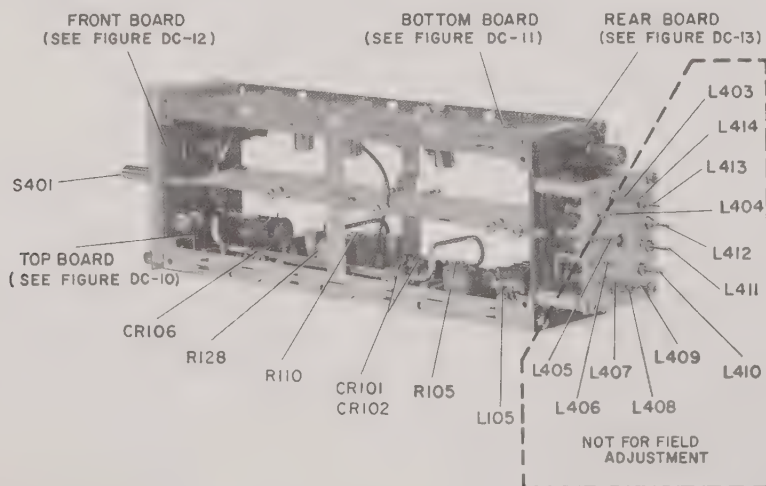


Figure DC-5. Interior of DI-4 module showing test points and secondary adjustment controls (unit inverted). Refer also to Table DC-1. DO NOT CHANGE SETTING OF L403-L414.

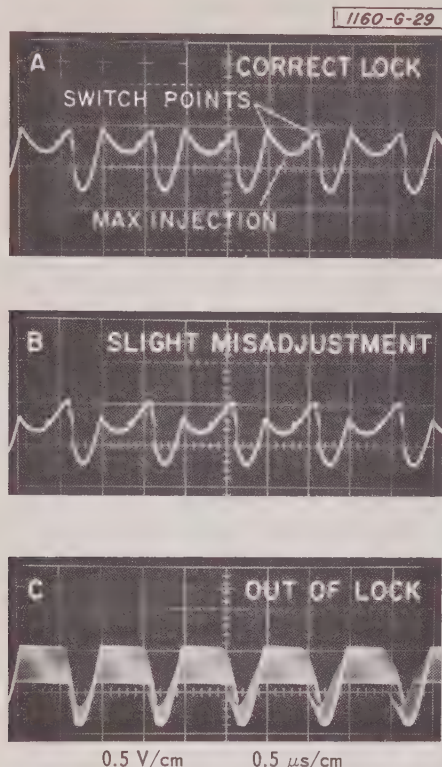


Figure DC-6. Injection-Locked Oscillator adjustment waveforms shown at TP101 (see Figure DC-4).

and Q203 on the bottom board. If the voltage is correct at AT207, but is incorrect elsewhere, the malfunction is in the DI-4. If AT207 indicates an incorrect voltage, check the power supply and chassis-power distribution in the sandwich deck (refer to Sections BB and GA).

DC-3.3.3 1-MC CIRCUITS.

With the oscilloscope, look for the 1-Mc input from the AFS module at J203. If the input signal is missing, distorted, or less than 0.7 V, rms, check the Main Frame (Section BB) and the AFS (Section CA). This test is independent of the settings of the synthesizer front panel controls.

If the 1-Mc input is adequate, observe the waveform at TP101 to check the 1-Mc isolation amplifier, Q204, and the 1-Mc Injection-Locked Oscillator, Q103/Q104. If a full sinewave appears, the oscillator is inoperative; if a half-wave-rectified sinewave appears, the isolation amplifier is not feeding a lock signal to the oscillator.

If necessary, adjust L106 to make the switching points equal in amplitude. Adjust T204 to maximize the injected signal to Q103 and Q104, as in Figure DC-6 (A). Figures DC-6 (B) and (C) show the oscillator out of adjustment.

If the oscillator cannot be brought into lock with L106, measure the frequency of the injection-locked oscillator directly, with the counter at TP101; clip a short lead across AT103 and AT104 (Figure DC-10), to remove the 1-Mc drive to the oscillator for this test.

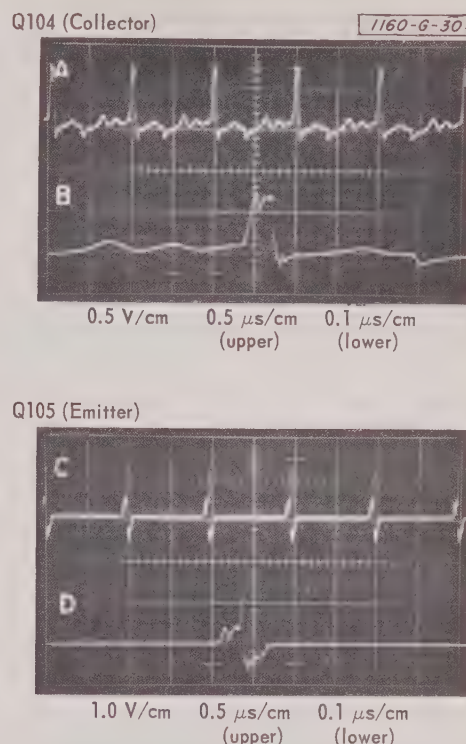


Figure DC-7. Typical input and output waveforms for the servo-circuit pulse amplifier (see Figure DC-10).

If the frequency is sufficiently removed from its nominal value, the oscillator will not lock.

DC-3.3.4 PULSE CIRCUITS.

The simplest approach to isolate trouble in stages Q103-Q106 is to signal-trace the various waveforms until a defective circuit is located. Figures DC-7 (A and B) show the waveform at the collector of Q104, the input to the pulse amplifier; the output at the emitter of Q105 is shown at Figure DC-7 (C and D).

R128 controls the amplitude of the blocking-oscillator pulse, the waveform of which can be observed at the collector of Q106 (case).

CAUTION

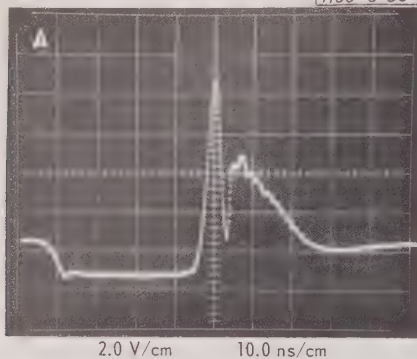
Do not change the setting of R128 unless there is a strong reason to do so, since a change in pulse amplitude can upset the sampler balance.

The sampling oscilloscope is needed for the remainder of the pulse circuits. Figure DC-8 (A) shows the output of the blocking oscillator at pin 1, T102, (use Figure DC-10 to find the test point). Figure DC-8 (B) shows the waveform at the anode of CR106. CR106, a plug-in unit, is selected to give the stored-charge, snap-off characteristics necessary to speed up the blocking-oscillator pulse. Ordinarily this diode should not need to be replaced—the jacks are utilized principally for factory selection of the diodes.

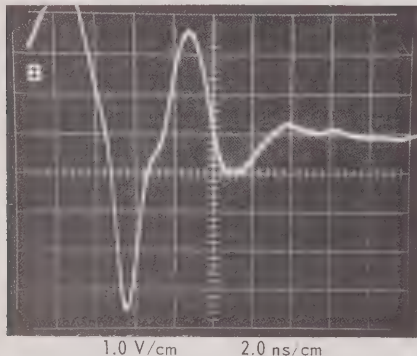


T102, Pin 1

1/60-6-30



CR106 Anode



TP103 (upper) TP102 (lower)

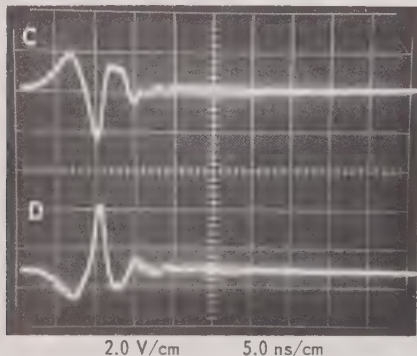


Figure DC-8. Sampling oscilloscope waveforms typical of servo-circuit blocking-oscillator performance.

The waveforms of the remainder of the pulse circuits are checked best when the Digit Oscillator is not running. To stop the oscillator, set the digit dial between steps. Observe the waveforms at TP102 and TP103; see Figure DC-8 (C and D). Diodes CR101 and CR102 must be removed for this test. They are plug-in units in the top circuit board (Figure DC-5). Note carefully the relative positions and polarizations of the diodes on the board prior to removal, so that they can be reinstalled exactly as they were originally.

Switch the digit selector back to one of the dial positions to restore operation of the Digit Oscillator. Reinstall the diodes.

CAUTION

Error in reinstallation of these diodes can adversely affect calibration of the entire module.

DC-3.3.5 RF CIRCUITS.

A rough estimate of the performance of the 39 to 50-Mc sections of the DI-4 module can be made by signal tracing with the oscilloscope and VTVM (see Figure DC-4).

A frequency equal to the digit-output frequency should be found progressively at the following points: AT205 at approximately 0.8 V, rms; J202 (rf Output) 0.3 V, rms (adjustable by R218); and AT201 and AT101 at about 50 - 100 mV, rms, depending on the factory setting of servo control loop-gain, (see Figure DC-11 for test points).

If gain control R210 or other elements in the servo loop become faulty, or misadjusted, the servo-control circuit may oscillate and inhibit normal phase-lock operation. Figure DC-9 is indicative of this symptom, as seen at AT107. This condition cannot be adjusted in the field.

CAUTION

Do not change the setting of R210.

DC-3.3.6 DC AMPLIFIER.

Table DC-3 includes the voltages that should be obtained in the dc amplifier circuits.

DC-3.3.7 NOTCH FILTER.

Remove Q106 to stop the pulse generator. Connect the VTVM (DC mode) to AT108 and adjust R105 to a 6.0 Vdc indication; a right-angle screwdriver can be used for this adjustment.

Connect two 33 kilohm resistors to the base of Q101A, one going to TP101 and the other to TP102,

TABLE DC-3

DC VOLTAGE INDICATIONS

Transistor	Emitter	Base	Collector
Q101A	5.5	6	14.5
Q101B	5.5	6	17.5
Q102	15	14.5	6
Q103	9.2	9.0	0.3
Q104	9.2	9.1	0+
Q105	0+	0+	16.8
Q106	0	-52	5.5
Q201	11.2	11.9	16.5
Q202	11.5	12.1	17.0
Q203	4.3	5.0	16
Q204	10	10.1	0
Q301	5.5	6.0	11
Q302	.063	.045	.058
Q401	11.5	12.2	17

(across the diodes), to maintain the bias on Q101A. Connect the signal generator, to the base of Q101A, through a 0.01- μ F coupling capacitor. Sweep through 1 Mc/s at 0.1 V, rms, and with the VTVM (ac mode), observe the voltage at AT108. The ac voltage output of the amplifier should go through a minimum at 1 Mc/s. If the notch can't be found, the unit must be returned to General Radio for realignment.

DC-3.4 DC VOLTAGE CHECKS.

The procedures in paragraph 3.3 should narrow the search for circuit defects to a circuit function consisting of one, or at the most, a few stages. As a further aid to pinpointing the defective part, the information on dc voltage readings is presented in Table DC-3.

DC-3.5 REPAIRS AND REPLACEMENT.

Replace defective detail parts (with frequency-insensitive functions) to correct deficiencies indicated by the trouble-analysis procedures.

CAUTION

Replacement of frequency-determining parts will require realignment which cannot be accomplished without special test fixtures.

AT107

1160-6-28

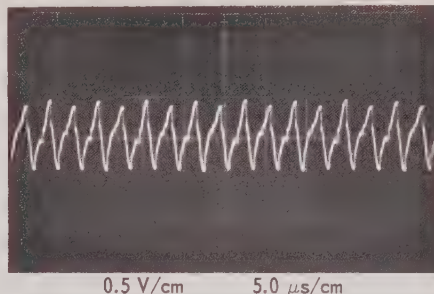


Figure DC-9. Typical waveform at AT107 indicating self-oscillation resulting from an incorrect setting of R210, the Digit Oscillator control-loop gain control.

Figures DC-10 through DC-13 show the physical layout of the parts on the various etched-circuit boards, to speed positive identification. The reference designators for the parts shown on the boards are the same as those used in the over-all schematic diagram, Figure DC-14, and in the parts list at the end of this section.

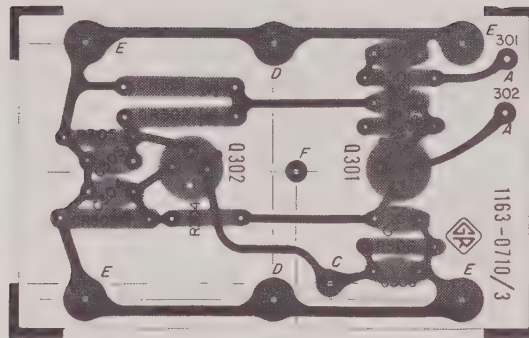


Figure DC-12. Etched-circuit board assembly (front)
for DI-4 (P/N 1163-2710).

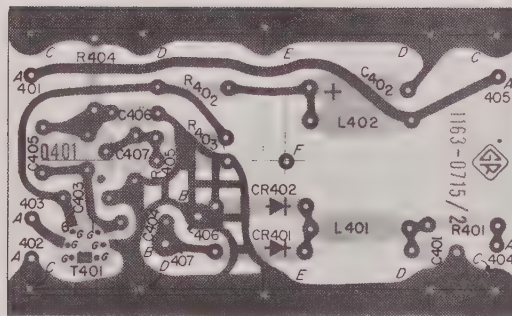


Figure DC-13. Etched-circuit board assembly (rear)
for DI-4 (P/N 1163-2716).

NOTE: The number appearing on the foil side is not the part number.
The dot on the foil at the transistor socket indicates the collector lead.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C101	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C102	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C103	Electrolytic, 2.2 μ F $\pm$ 20% 20 V	4450-4500	56289	150 D225 x 0020 A2	
C104	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-976-4604
C105	Ceramic, 10 pF $\pm$ 5% 500 V (NPO)	4410-0105	80131	CC60, 10 pF $\pm$ 5%	5910-974-5697
C106	Ceramic, 27 pF $\pm$ 5% 500 V (N750)	4417-0275	80131	CC60, 27 pF $\pm$ 5%, 500V	
C107	Mica, 243 pF $\pm$ 1% 500 V	4710-0424	14655	22 A, 243 pF $\pm$ 1%	
C108	Ceramic, 20 pF $\pm$ 5% 500 V (N150)	4413-0205	80131	CC62, 20 pF $\pm$ 5%, 500V	5910-976-4604
C109	Electrolytic, 2.2 μ F $\pm$ 20% 20 V	4450-4500	56289	150 D225 x 0020 A2	
C110	Electrolytic, 1.0 μ F $\pm$ 20% 35 V	4450-4300	56289	150 D105 x 0035 A2	
C111	Mica, 508 pF $\pm$ 1% 500 V	4710-0579	14655	22 A, 508 pF $\pm$ 1	5910-912-1986
C112	Ceramic, 91 pF $\pm$ 5% 300 V (N750)	4417-0915	80131	CC62, 91 pF $\pm$ 5%	5910-726-5003
C113	Ceramic, 10 pF $\pm$ 5% 500 V (NPO)	4410-0105	80131	CC60, 10 pF $\pm$ 5%	
C114	Electrolytic, 1.0 μ F $\pm$ 20% 35 V	4450-4300	56289	150 D105 x 0035 A2	
C115	Ceramic, 0.0047 μ F +80-20% 500 V	4405-2479	72982	801, 0.0047 μ F +80-20%	5910-726-5003
C116	Ceramic, 470 pF $\pm$ 10% 500 V	4405-1478	72982	801, 470 pF $\pm$ 10%	
C117	Electrolytic, 1.0 μ F $\pm$ 20% 35 V	4450-4300	56289	150 D105 x 0035 A2	
C118	Ceramic, 0.02 μ F +80-20% 50 V	4402-3200	01121	35-203W	5910-952-8659
C201	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, .001 μ F $\pm$ 10%	5910-974-5697
C202	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C203	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C204	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-974-5697
C205	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C206	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C207	Ceramic, 0.01 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.01 μ F $\pm$ 10%	5910-974-5697
C208	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.01 μ F $\pm$ 10%	5910-914-0087
C209	Ceramic, 0.01 +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C210	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C211	Ceramic, 0.01 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.01 μ F $\pm$ 10%	5910-914-0087
C212	Mica, 508 pF $\pm$ 1%	4710-0579	14655	22 A, 508 pF $\pm$ 10%	5910-912-1986
C213	Ceramic, 91 pF $\pm$ 5% (N750)	4417-0915	80131	CC62, 91 pF $\pm$ 5%	5910-974-5697
C214	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	
C215	Electrolytic, 2.2 μ F $\pm$ 20% 20 V	4450-4500	56289	150 D225 x 0020 A2	
C216	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C217	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C301	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C302	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C303	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C304	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-10%	5910-974-5697
C305	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-10%	5910-974-5697
C306	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-10%	5910-974-5697
C401	Ceramic, 20 pF $\pm$ 5% 500 V (N750)	4417-0205	80131	CC60, 20 pF $\pm$ 5%	5910-726-5003
C402	Electrolytic, 1.0 μ F $\pm$ 20% 35 V	4450-4300	56289	150 D105 x 0035 A2	
C403	Ceramic, 0.0022 μ F +80-20% 500 V	4404-2229	72982	831, 0.0022 μ F +80-20%	
C404	Ceramic, 24 pF $\pm$ 5% 500 V (N750)	4417-0335	80131	CC60, 24 pF $\pm$ 5%	5910-952-8403
C405	Ceramic, 24 pF $\pm$ 5% 500 V (N750)	4417-0335	80131	CC60, 24 pF $\pm$ 5%	
C406	Ceramic, 180 pF $\pm$ 5% 500 V	4404-1185	72982	831, 180 pF $\pm$ 5%	
C407	Ceramic, 0.0022 μ F +80-20% 500 V	4404-2229	72982	831, 0.0022 μ F +80-20%	
DIODES					
CR101	Semiconductor, Assembly	1164-2010	24655	1164-2010	5960-984-3570
CR102	Semiconductor, Assembly	1164-2010	24655	1164-2010	
CR103	Semiconductor, type 1N746	6083-1005	07910	1N 746	
CR105	Semiconductor, type 1N191	6082-1008	93916	1N 191	5961-296-3360
CR106	Semiconductor, type 1N3604	6082-1001	24446	1N 3604	5960-995-2199
CR301	Semiconductor, type 1N191	6082-1008	93916	1N 191	5961-296-3360
CR302	Semiconductor, type 1N191	6082-1008	93916	1N 191	5961-296-3360
CR303	Semiconductor, type 1N191	6082-1008	93916	1N 191	5961-296-3360
CR401	Semiconductor, type VA-134	6084-1010	04264	AV 134	5961-944-8222
CR402	Semiconductor, type VA-134	6084-1010	04264	AV 134	
INDUCTORS					
L101	Choke, iron core 1.5 μ H $\pm$ 10%	4300-1000	99800	1537, 1.5 μ H $\pm$ 10%	5950-668-5867
L102	Choke, iron core 1.5 μ H $\pm$ 10%	4300-1000	99800	1537, 1.5 μ H $\pm$ 10%	
L103	Choke, iron core 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	
L104	Ferrite cup, adjustable	5000-2832	24655	5000-2832	5950-668-5867
L105	Ferrite cup, adjustable	5000-2833	24655	5000-2833	
L106	Ferrite cup, adjustable	5000-2834	24655	5000-2834	
L107	Choke, iron core 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L108	Choke, iron core 1.5 μ H $\pm$ 10%	4300-1000	99800	1537, 1.5 μ H $\pm$ 10%	
L201	Choke, iron core 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
INDUCTORS (cont)					
L401	Choke, iron core 4.7 $\mu\text{H} \pm 10\%$	4300-1600	99800	1537-28, 4.7 $\mu\text{H} \pm 10\%$	
L402	Choke, iron core 22 $\mu\text{H} \pm 10\%$	4300-2600	99800	1537, 22 $\mu\text{H} \pm 10\%$	
L403	Ceramic, iron core, adjustable	1163-2200	24655	1163-2200	
L404	Ceramic, iron core, adjustable	1163-2200	24655	1163-2200	
L405	Ceramic, iron core, adjustable	1163-2200	24655	1163-2200	
L406	Ceramic, iron core, adjustable	1163-2200	24655	1163-2200	
L407	Ceramic, iron core, adjustable	1163-2210	24655	1163-2210	
L408	Ceramic, iron core, adjustable	1163-2210	24655	1163-2210	
L409	Ceramic, iron core, adjustable	1163-2210	24655	1163-2210	
L410	Ceramic, iron core, adjustable	1163-2210	24655	1163-2210	
L411	Ceramic, iron core, adjustable	1163-2220	24655	1163-2220	
L412	Ceramic, iron core, adjustable	1163-2220	24655	1163-2220	
L413	Ceramic, iron core, adjustable	1163-2220	24655	1163-2220	
L414	Ceramic, iron core, adjustable	1163-2220	24655	1163-2220	
RESISTORS					
R101	Film, 4.99 $\text{k}\Omega \pm 1\%$ 1/8 W	6250-1499	75042	CEA, 4.99 $\text{k}\Omega \pm 1\%$	
R102	Film, 2 $\text{k}\Omega \pm 1\%$ 1/8 W	6250-1200	75042	CEA, 2 $\text{k}\Omega \pm 1\%$	5905-577-6614
R103	Film, 11 $\text{k}\Omega \pm 1\%$ 1/8 W	6250-2110	75042	CEA, 11 $\text{k}\Omega \pm 1\%$	
R104	Composition, 10 $\text{M}\Omega \pm 5\%$ 1/4 W	6099-6105	75042	BTS, 10 $\text{M}\Omega \pm 5\%$	
R105	Potentiometer, composition 100 $\text{k}\Omega \pm 20\%$	6040-1000	01121	FWC, 100 $\text{k}\Omega \pm 20\%$	5905-958-7949
R106	Film, 20 $\text{k}\Omega \pm 1\%$ 1/8 W	6250-2200	75042	CEA, 20 $\text{k}\Omega \pm 1\%$	5905-702-5971
R107	Composition, 33 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3335	75042	BTS, 33 $\text{k}\Omega \pm 5\%$	
R108	Composition, 3.9 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2395	75042	BTS, 3.9 $\text{k}\Omega \pm 5\%$	
R109	Composition, 47 $\Omega \pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 $\Omega \pm 5\%$	
R110	Potentiometer, composition 100 $\Omega \pm 20\%$	6040-0100	24655	6040-0100	
R111	Composition, 33 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3335	75042	BTS, 33 $\text{k}\Omega \pm 5\%$	
R112	Film, 10 $\text{k}\Omega \pm 1\%$ 1/8 W	6250-2100	75042	CEA, 10 $\text{k}\Omega \pm 1\%$	5905-883-4847
R113	Composition, 22 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3225	75042	BTS, 22 $\text{k}\Omega \pm 5\%$	5905-687-0002
R114	Composition, 6.8 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2685	75042	BTS, 6.8 $\text{k}\Omega \pm 5\%$	5905-686-9997
R115	Composition, 4.7 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2475	75042	BTS, 4.7 $\text{k}\Omega \pm 5\%$	5905-686-9998
R116	Composition, 10 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 $\text{k}\Omega \pm 5\%$	5905-683-2238
R117	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 $\text{k}\Omega \pm 5\%$	5905-683-2238
R118	Composition, 10 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 $\text{k}\Omega \pm 5\%$	5905-683-2238
R119	Composition, 3.3 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 $\text{k}\Omega \pm 5\%$	5905-681-9969
R120	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 $\Omega \pm 5\%$	
R121	Composition, 330 $\Omega \pm 5\%$ 1/4 W	6099-1335	75042	BTS, 330 $\Omega \pm 5\%$	5905-686-3369
R122	Composition, 680 $\Omega \pm 5\%$ 1/4 W	6099-1685	75042	BTS, 680 $\Omega \pm 5\%$	
R123	Composition, 4.7 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2475	75042	BTS, 4.7 $\text{k}\Omega \pm 5\%$	5905-686-9998
R124	Composition, 220 $\Omega \pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 $\Omega \pm 5\%$	5905-683-2240
R125	Composition, 150 $\Omega \pm 5\%$ 1/4 W	6099-1155	75042	BTS, 150 $\Omega \pm 5\%$	5905-683-2243
R126	Composition, 820 $\Omega \pm 5\%$ 1/4 W	6099-1825	75042	BTS, 820 $\Omega \pm 5\%$	
R127	Composition, 220 $\Omega \pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 $\Omega \pm 5\%$	5905-683-2240
R128	Potentiometer, wire-wound 2 $\text{k}\Omega \pm 5\%$	6053-1105	80294	3307W, 2 $\text{k}\Omega \pm 5\%$	
R129	Composition, 3.3 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 $\text{k}\Omega \pm 5\%$	5905-681-9969
R201	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 $\Omega \pm 5\%$	
R202	Composition, 6.8 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2685	75042	BTS, 6.8 $\text{k}\Omega \pm 5\%$	5905-686-9997
R203	Composition, 18 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3185	75042	BTS, 18 $\text{k}\Omega \pm 5\%$	5905-687-0000
R204	Composition, 1 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 $\text{k}\Omega \pm 5\%$	5905-681-6462
R205	Composition, 22 $\Omega \pm 5\%$ 1/4 W	6099-0225	75042	BTS, 22 $\Omega \pm 5\%$	5905-279-5459
R206	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 $\Omega \pm 5\%$	
R207	Composition, 6.8 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2685	75042	BTS, 6.8 $\text{k}\Omega \pm 5\%$	5905-686-9997
R208	Composition, 18 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3185	75042	BTS, 18 $\text{k}\Omega \pm 5\%$	5905-687-0000
R209	Composition, 1.5 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2155	75042	BTS, 1.5 $\text{k}\Omega \pm 5\%$	
R210	Potentiometer, composition 100 $\Omega \pm 20\%$	6040-0100	24655	6040-0100	
R211	Composition, 12 $\Omega \pm 5\%$ 1/4 W	6099-0125	75042	BTS, 12 $\Omega \pm 5\%$	5905-279-5455
R212	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 $\Omega \pm 5\%$	
R213	Composition, 51 $\Omega \pm 5\%$ 1/4 W	6099-0515	75042	BTS, 51 $\Omega \pm 5\%$	
R214	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 $\Omega \pm 5\%$	
R215	Composition, 4.7 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2475	75042	BTS, 4.7 $\text{k}\Omega \pm 5\%$	5905-686-9998
R216	Composition, 2.2 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2225	75042	BTS, 2.2 $\text{k}\Omega \pm 5\%$	5905-723-5251
R217	Composition, 270 $\Omega \pm 5\%$ 1/4 W	6099-1275	75042	BTS, 270 $\Omega \pm 5\%$	
R218	Potentiometer, composition 100 $\Omega \pm 20\%$	6040-0100	24655	6040-0100	
R219	Composition, 220 $\Omega \pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 $\Omega \pm 5\%$	5905-683-2240
R220	Composition, 3.3 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 $\text{k}\Omega \pm 5\%$	5905-681-9969
R221	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 $\Omega \pm 5\%$	
R222	Composition, 8.2 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-2825	75042	BTS, 8.2 $\text{k}\Omega \pm 5\%$	
R223	Composition, 10 $\text{k}\Omega \pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 $\text{k}\Omega \pm 5\%$	5905-683-2238
R224	Composition, 33 $\Omega \pm 5\%$ 1/4 W	6099-0335	75042	BTS, 33 $\Omega \pm 5\%$	
R225	Composition, 470 $\Omega \pm 5\%$ 1/4 W	6099-1475	75042	BTS, 470 $\Omega \pm 5\%$	5905-683-2242
R301	Composition, 220 $\Omega \pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 $\Omega \pm 5\%$	5905-683-2240
R302	Composition, 820 $\Omega \pm 5\%$ 1/4 W	6099-1825	75042	BTS, 820 $\Omega \pm 5\%$	
R304	Composition, 680 $\Omega \pm 5\%$ 1/4 W	6099-1685	75042	BTS, 680 $\Omega \pm 5\%$	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
RESISTORS (Cont)					
R305	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9998
R306	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R401	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm$ 5%	
R402	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R403	Composition, 33 k Ω $\pm$ 5% 1/4 W	6099-3335	75042	BTS, 33 k Ω $\pm$ 5%	
R404	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	5905-681-9969
R405	Composition, 150 k Ω $\pm$ 5% 1/4 W	6099-4155	75042	BTS, 150 k Ω $\pm$ 5%	5905-686-9995
TRANSISTORS					
Q101	Type 2N2453	8210-1046	24446	2N 2453	
Q102	Type 2N3250	8210-1089	80211	2N 3250	5961-945-4108
Q103	Type 2N3638	8210-1096	07263	2N 3638	5961-912-9008
Q104	Type 2N3638	8210-1096	07263	2N 3638	5961-912-9008
Q105	Type 2N708	8210-3089	24454	2N 708	5961-954-6100
Q106	Type 2N2369	8210-1052	93916	2N 2369	5960-682-7755
Q201	Type 2N708	8210-3089	24454	2N 708	5961-954-6100
Q202	Type 2N708	8210-3089	24454	2N 708	5961-954-6100
Q203	Type 2N2218	8210-1028	81349	2N 2218	5960-059-4464
Q204	Type 2N3638	8210-1096	07263	2N 3638	5961-912-9008
Q301	Type SE4002	8210-1077	24454	2N 3390	
Q302	Type 2N1305	8210-1305	96214	2N 1305	5961-853-1079
Q401	Type 2N918	8210-1066	07263	2N 3563	
MISCELLANEOUS					
Z101	Delay line, rigid-wall coaxial, miniature	1163-0201	24655	1163-0201	
Z102	Delay line, rigid-wall coaxial, miniature	1163-0202	24655	1163-0202	
Z103	Delay line, rigid-wall coaxial, miniature	1163-0203	24655	1163-0203	
Z104	Delay line, rigid-wall coaxial, miniature	1163-0204	24655	1163-0204	
Z201	Delay line, rigid-wall coaxial, miniature	1163-0200	24655	1163-0200	
J201	JACK, etched-circuit, eyelet-type	1160-6110	24655	1160-6110	
J202	JACK, etched-circuit, eyelet-type	1160-6110	24655	1160-6110	
J203	JACK, etched-circuit, eyelet-type	1160-6110	24655	1160-6110	
S401	SWITCH, rotary wafer	7890-4300	24655	7890-4300	
T101	TRANSFORMER, video, interstage	5000-2403	24655	5000-2403	
T102	TRANSFORMER, video, interstage	5000-2601	24655	5000-2601	
T103	TRANSFORMER, video, interstage	5000-2403	24655	5000-2403	
T201	TRANSFORMER, video, interstage	5000-2401	24655	5000-2401	
T202	TRANSFORMER, video, interstage	5000-2401	24655	5000-2401	
T203	TRANSFORMER, video, interstage	5000-2401	24655	5000-2401	
T204	TRANSFORMER, ferrite cup, adjustable	5000-2835	24655	5000-2835	
T401	TRANSFORMER, ferrite cup, adjustable	5000-2602	24655	5000-2602	
CIRCUIT BOARD - ASSEMBLIES					
Top circuit board		1163-2702	24655	1163-2702	
Bottom circuit board		1163-2707	24655	1163-2707	
Front circuit board		1163-2710	24655	1163-2710	
Rear circuit board		1163-2716	24655	1163-2716	

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

- NOTE UNLESS SPECIFIED
- 1 POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE
 - 2 CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK
 - 3 REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM
 - 4 RESISTORS 1/4 WATT
 - 5 RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
 - 6 CAPACITANCE VALUES ONE AND OVER IN PICOFARADS LESS THAN ONE IN MICROFARADS.
 - 7 KNOB CONTROL
 - 8 SCREWDRIVER CONTROL
 - 9 AT ANCHOR TERMINAL
 - 10 TP TEST POINT

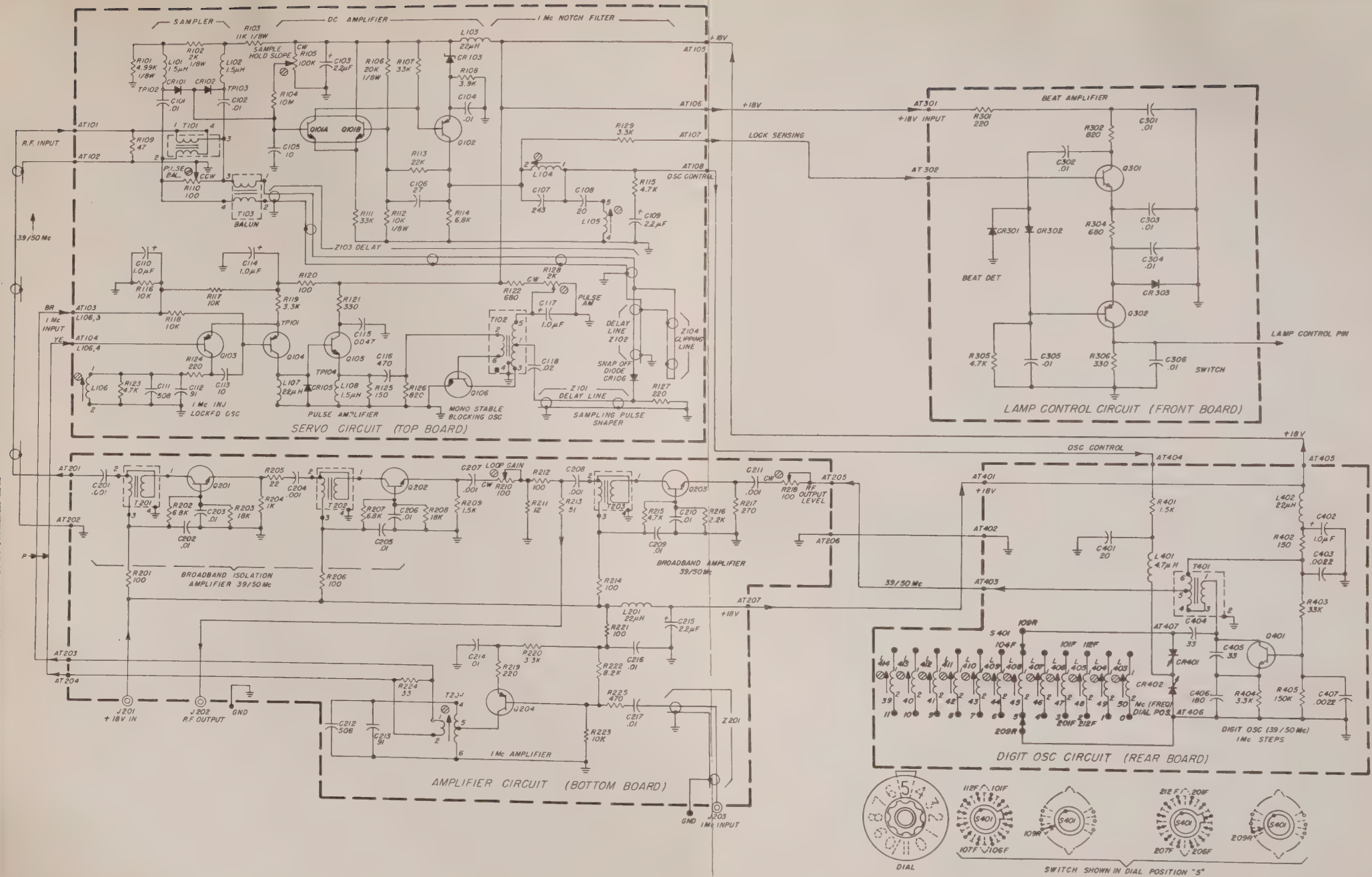
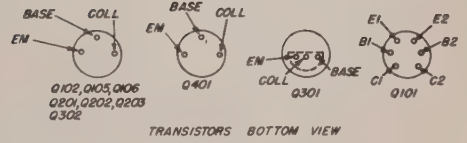


Figure DC-14. Over-all schematic diagram for the Digit-Insertion Unit DI-4 (P/N 1163-4000).

section **DD**

REMOTE DIGIT-INSERTION UNIT - RDI-4

P/N 1163-4005

(Used only in the Type 1163 Synthesizer)

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SECTION DD-1

INTRODUCTION

DD-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis."

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension by experienced service personnel of the principles of operation. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate part identification, reference designators used in the text and appearing on the photographs are the same as those used on the complete schematic diagram and in the parts list.

The service instructions rely on the use of a properly functioning synthesizer as a basic test frame for an individual module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the wide-spread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty.

DD-1.2 PURPOSE.

The RDI-4 Digit-Insertion Unit is an alternate to the DI-4 Digit-Insertion Unit, used in the General Radio 1163 12-MHz frequency synthesizer. It differs from

the DI-4 in that remote frequency selection is provided for in the RDI-4. Otherwise, the two modules are directly interchangeable and serve identical functions in the instrument, which is to furnish 1-MHz user-selected steps in the instrument output.

The DI-4 and RDI-4 differ completely in function and electrical design from the remaining digit insertion units, and, although similar in mechanical configuration to the others, are not interchangeable with them.

Mounting arrangements in the chassis are identical with those of the other DI units, consisting of two front-panel screws, a plastic dial-lamp holder and dial, and a hold-down clamp at the rear of the module on the sandwich deck of the chassis. (For a description of the DI modules, providing all digit steps below 1 MHz, refer to Section DI of this manual).

DD-1.3 DESCRIPTION.

DD-1.3.1 GENERAL.

The RDI-4 Digit-Insertion unit, with its cover installed, is shown in Figure DD-1. The only exter-

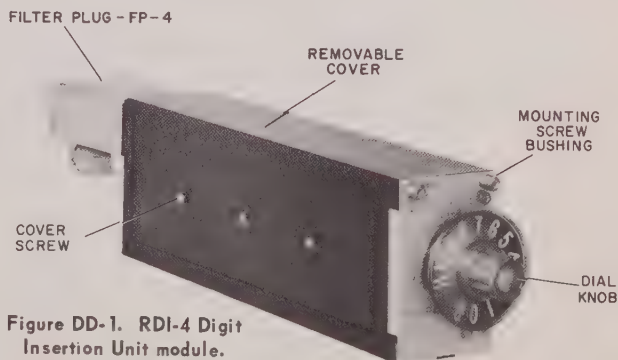


Figure DD-1. RDI-4 Digit Insertion Unit module.



Figure DD-2. Panel view of the Type 1163-AR7C Coherent Decade Frequency Synthesizer with all digits set for programmable operation.

nal operator control of the unit, the digit-selector switch, is operated by the 1/4-inch shaft and the dial knob visible in front. The twelve numbered positions of the dial permit manual frequency selection. The thirteenth position marked "R", transfers control of the frequency setting to the leads in the control cable at the rear of the unit. Figure DD-2 shows a synthesizer with digit-selection controls set for remotely programmable operation.

Connections for remote frequency selection are made through the filter plug shown at the rear of the RDI unit in Figure DD-1. Figure DD-3 shows the filter plugs connected to the rear of the programmable digit stations of a synthesizer. The filter plug engages a connector protruding through the rear wall of the RDI unit and the attaching screw threads into the support bar across the back of the synthesizer.

A small plastic lamp holder, which is part of the RDI-4 as supplied, fits in the synthesizer panel behind the control knob. This holder permits installation of the dial lamp in the instrument front panel, behind the dial, after the RDI-4 has been mounted in

the Main Frame (see Figure 5-2 in the systems portion of this manual).

The entire RDI-4 assembly is held in the Main Frame by two 4-40 screws that engage the threaded bushings in the top corners of its small front panel and by a hold-down clamp that secures the reinforced bottom of the cover unit at the rear, through a small cutout.

All electrical connections to the Main Frame, except one are made by banana-type plugs through the bottom of the cover into the RDI assembly. The dial lamp is energized and switched in the Main Frame as explained in Section 4.6 (system portion). It can also be controlled from the RDI, and this control-signal connection is made by a small pin in the RDI front panel to a spring contact on the instrument front panel. This pin is part of a phase-error sensing circuit that extinguishes the lamp if phase lock is broken. All connections are thus established automatically when the unit is installed.

No. 4-40 screws on either side of the unit fasten the cover to the Digit-Insertion unit frame structure.

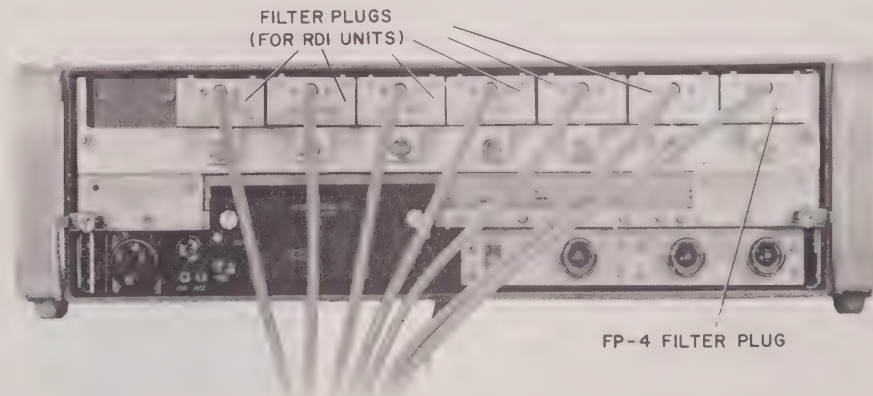


Figure DD-3. Rear view of the synthesizer of Figure DD-2, showing plug-in filters and remote cabling.

After their removal, the unit can be withdrawn from the cover, if the case is held in one hand and the unit is pulled by its switch shaft with the other.

The circuitry of the RDI is contained on five etched-circuit boards. They are the long horizontal top and bottom boards and the smaller vertical front and rear circuit boards. These boards mount all components and furnish most of the electrical connections between them. In the bottom board are 3 banana jacks and 2 special ground contacts, which make the electrical connections to the Main Frame mentioned earlier.

Signal flow and circuit layout are so arranged that a minimum of wiring between boards is required and each individual board assembly can be removed from the structure, after connecting-wire leads have been unsoldered and appropriate screws removed. There is, however, enough space in almost all instances to permit removal of components without board removal.

The side rails of the top and bottom boards are equipped with special ground springs to ensure intimate contact with the cover. The 6 threaded inserts, which accept the 4-40 screws that hold the cover, establish fixed contact areas between shield partition and cover. A finger-stock rf seal is used where the cover and front panel join.

DD-1.3.2 ELECTRICAL CHARACTERISTICS.

Circuits are divided functionally at the circuit-board level, making component locations largely self-explanatory.

The RDI-4 unit supplies signal outputs, frequency coherent with the master quartz oscillator in the AFS unit, necessary to produce the 1-MHz digit steps in the synthesizer. The function of this module in the operation of the synthesizer is described more fully in Section 4 of the front portion of this manual.

To form the 12 frequency steps (50 to 39-MHz steps) coherently from the master crystal oscillator, the RDI-4 accepts as an input, a 1-MHz sinewave from the sandwich deck. The 1-MHz signal is generated in the AFS unit, by frequency division from the 5-MHz crystal oscillator (refer to Section CA of this manual). This 1-MHz input to the RDI-4 is used as the reference to phase-lock an oscillator, which has been rough-tuned by the dial switch, to any one of the desired 50 to 39-MHz output frequencies of the RDI-4. This principle is discussed more fully in Section DD-2.

The other external connections for the RDI-4 consists of the +18-volt No. 1 input from the power supply and the external lamp-control pin. The lamp-control circuit is so arranged that, if the digit oscillator fails to lock, the lamp-control pin is de-energized and extinguishes the lamp in the lamp-control assembly on the front panel, to give warning of failure.

DD-1.4 INSTALLATION.

DD-1.4.1 GENERAL.

If the RDI-4 unit is to be added to an 1163 to convert the 1-MHz step-digit station from manual control to programmable operation, observe the procedures that follow to install the unit.

DD-1.4.2 DIGIT CONVERSION.

To convert a manual-step-digit station from the DI-4 to RDI-4, proceed as follows:

a. Remove the four knurled screws on the front panel of the synthesizer (accessible through cutouts in the handles), release the two cabinet clamps at the rear of the chassis, and withdraw the instrument from its cabinet.

b. Remove the two Phillips-head screws at the ends of the dial strip, along the top of the front panel, and dismount the strip.

c. Set the DI-4 unit dial knob to "5" and pull the knob straightaway from the module. Release the lock screws in the bushing affixed to the dial and pull that assembly off the shaft.

d. Release the screw-actuated clamp (mounted on the chassis at the rear of the module). Turn the clamp CCW to swing it out of the recess in the DI-4 cover.

e. Withdraw the dial-light assembly from its mounting in the keyhole panel cutout. Remove the two screws at the top of the dial-light assembly.

f. Work the unit off the banana-plug attachment to the chassis, lift it clear of the plugs and draw it up and to the rear, so that the dial shaft clears the panel.

g. Remount the dial knob on the module and store the unit carefully.

h. Make sure that the filter plug is disconnected from the RDI module, that the dial knob is removed, and that the digit-selector shaft is set fully CCW.

i. Insert the selector shaft through the keyhole opening in the front panel of the synthesizer, place the unit over the banana plugs protruding from the chassis in the digit station, and press down gently to engage the plugs. Reinstall the front-panel screws.

j. Swing the chassis clamp bar into the recess in the rear of the module and tighten the screw there.

k. Remount the dial-light, the RDI-4 dial, and the knob. The procedure is the reverse of steps a through f. The dial should show "R" when the shaft is full CCW. The shaft must not protrude through bushing, or the knob won't seat.

DD-1.4.5 FILTER-PLUG WIRING.

The Filter Plug, FP-4, must be wired to the external programmer. For synthesizers purchased initially with programmable digits, a 50-foot roll of special 12-wire cable is furnished. For conversions or expansions this cable is recommended as an accessory available; the catalog number is 1160-9650 (50-foot lengths). See Figure DD-4 for a completed FP-4 assembly and Figure DD-5 for cable preparation details.

To wire a Filter Plug proceed as follows:

a. Remove the three Phillips-head screws on the top of the plug assembly, to release the cover, and pull it off the unit.

b. Release the two Phillips-head screws and remove the cable-clamp-and-ferrule assembly at the rear of the plug.

c. Remove the brass shipping clip from the clamp assembly. Carefully set aside the 3/16-inch ferrule and the 3/8-inch Teflon sleeve.

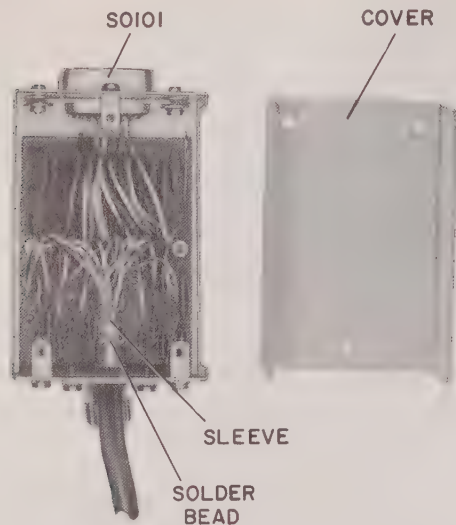


Figure DD-4. Interior view of Filter Plug FP-4 showing remote wiring connection.

o. Strip the ends of the individual leads (1/4-inch) and tin the exposed wires. Cut 1/8-inch off the ends of the tinned leads. Reinstall the completed clamp assembly in the plug.

p. Press individual leads into selected lugs and solder each one at the time of insertion. (Refer to Table DD-1 for sequence and lug-selection details.)

q. Dress the leads as shown in Figure DD-4. The planned slack in the leads provides service loops that permit easy alteration of the wiring at a later time if desired.

DD-1.4.4 WIRING-CODE SELECTION.

The leads of the special 12-conductor cable can be soldered to the lugs of the FP-4 Filter Plug etched board by either of two recommended systems. These systems differ in that one provides programming for all digits ("0" thru "11") while the other provides only for digits "0" thru "9" plus a lead to carry +18 Vdc to the remote location. The latter system is the sequence used in the patch cord for connection between

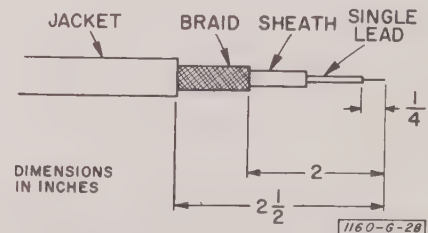


Figure DD-5. Remote-programming control cable preparation details.

d. Insert the cable through the flanged end of the opening in the clamp, so that at least 4 inches protrudes.

e. Strip 2 1/2 inches of the grey vinyl jacket from the end of the cable, taking care not to sever the braid underneath it (see Figure DD-5).

f. Remove 2 inches of the braid, measured from the end of the cable. Take care not to unravel the Mylar sheath.

g. Expand the Teflon heat-shield sleeve just enough to allow it to pass over the Mylar sheath. Use the end of a pair of needle-nose pliers.

h. Install the Teflon heat-shield sleeve over the end of the Mylar sheath and cable, approximately 1/2 inch.

i. Pull the cable back through the clamp assembly, until the end of the jacket is 1/8-inch inside the clamp.

j. Fold the braid back over the outside surface of the clamp and trim the flared ends so that they are just short of touching the shoulder of the clamp.

k. Slip the ferrule over the end of the cable and press it over the braid, back far enough for 1/8-inch of braid to be exposed at the inside end.

l. Press the Teflon sleeve back under the clamp assembly so that no more than 1/4-inch of the sleeve is still visible.

NOTE

The ferrule should not touch the shoulder of the clamp assembly.

m. Run a solder bead completely around the inside end of the assembly to bond the ferrule to the braid and to the clamp.

n. Unravel the Mylar sheath back to the Teflon heat-shield sleeve and cut off.

the RDI-4 and the Type 1160-P1 Programmer. Note that for system 2, one wire is soldered to the "D" terminal, a storage terminal for the unused wire in the cable. This wire serves an optional function in the Type 1160-P1, and is described in the Type 1160-P1 instruction manual. If necessary, this wire is used to program digit "10" or "11". Also, if both "10" and "11" are needed, a wire can be borrowed from one of the lower digits.

DD-1.4.5 FINAL INSTALLATION.

To complete the installation of the RDI-4, proceed as follows:

a. Reinstall the cover and attach the FP-4 to the connector protruding through the rear of the RDI-4 unit.

b. Thread the clamp screw on the bottom of the plug into the tapped hole in the support bar at the rear of the synthesizer and finger tighten.

TABLE DD-1
CONTROL-CABLE CONNECTION (See Figures DD-4 and DD-22)

FP-4 Lug Marking	System 1 "0" thru "11" Programming, No +18 Vdc	System 2 "0" thru "9" Programming* +18 Vdc Available - Special Lead Available	Digit Output for Closure to COM Lead**
1	White with brown trace	White with brown trace	1
2	White with red trace	White with red trace	2
3	White with orange trace	White with orange trace	3
4	White with yellow trace	White with yellow trace	4
5	White with green trace	White with green trace	5
6	White with blue trace	White with blue trace	6
7	White with violet trace	White with violet trace	7
8	White with grey trace	White with grey trace	8
9	White with black trace	White with black/brown trace	9
10	White with black/brown trace	_____	10
11	White with black/blue trace	_____	11
GND	_____	_____	_____
+18 V	_____	White with blue/black trace	_____
COM	White with blue/brown trace	White with blue/brown trace	_____
"D"	_____	White with black trace	_____

*Required for use with 1160-P1 Programmer.

**Digit 0 is obtained when no lead is closed to COM.

c. Select an adequate length for the cable to reach the programmer and cut the cable. Attach it to the programmer, observing the color-code selections indicated in Table DD-1.

DD-1.5 OPERATION.

DD-1.5.1 GENERAL.

The selection of an RDI-4 digit frequency, from a remote location connected to the synthesizer by wires, is accomplished by establishing connections between these wires. As long as the dial of the RDI-4 unit is set to one of the digits 0-11, the digit frequency corresponding to this local selection is generated regardless of any normal remote-wire connection. In the "R" dial position, control of frequency is trans-

ferred to the output terminals of the FP-4 unit, from which point it may be extended as desired.

For programmed operation, the unit is controlled by a 12-line code. Digit selection can be accomplished by closure between wires by contact, by transistor switch, or other suitable means. Switching power is internally supplied. The time interval occurring between contact closure and the presence of a newly selected frequency is 0.2 ms, maximum.

DD-1.5.2 TWELVE-LINE OPERATION.

In the twelve-line mode each digit selection is made by one closure only, consequently 12 wires (one COMMON and 11 digit leads) are required. The code is listed in Table DD-1 - all closures are to the common lead.



SECTION DD-2

PRINCIPLES OF OPERATION

DD-2.1 GENERAL.

In this section, reference is made to the elementary block diagram, Figure DD-6, and the complete schematic diagram, Figure DD-21.

The principal circuit in the RDI-4 is a sampled-data, automatic-phase-control system that uses 1 MHz as a reference signal to lock a rough-tuned oscillator to a multiple of 1 MHz, chosen in the band of frequencies from 50 to 39 MHz.

The 1-MHz sinewave input is converted to a short-duration, high-peak-power pulse with a 1-MHz repetition rate. This pulse is used to operate a gate

connected to the output of the digit oscillator which, when opened by the pulse, connects the output of the oscillator to a holding capacitor that stores the instantaneous value of the oscillator output voltage when the sampling pulse occurs. If the oscillator is tuned exactly to an integer multiple of the 1-MHz input, the value of the sample is the same each time and the voltage on the holding capacitor is dc. If there is a difference between the oscillator frequency and the corresponding multiple of the 1-MHz input reference, a stepwise sinewave signal results, which represents the drift between the oscillator and the closest multiple of the 1-MHz reference. The amplified holding-capacitor voltage is used as an error signal to phase-

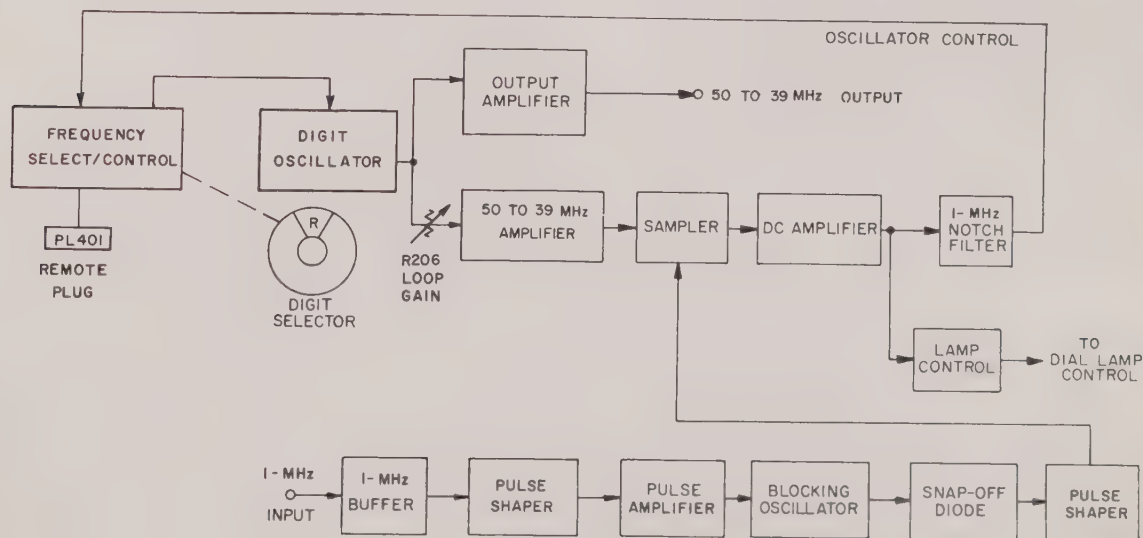


Figure DD-6. RDI-4 block diagram.

1163-25X

Base, Q105A

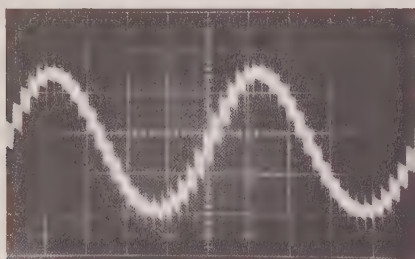


Figure DD-7. Step-wise sinewave signal at the base of Q105 indicative of the operation of the sampler circuit in response to oscillator drift.

lock the oscillator. Figure DD-7 shows the nature of this error signal.

Since an ac component of the error signal is present only when the oscillator is not locked, it can be used to indicate malfunction. The error signal is sensed for presence of ac; and, if ac is found, the dial lamp is extinguished (refer to paragraph DD-2.8).

The operating principles of individual circuits are discussed in more detail below.

DD-2.2 PULSE GENERATOR.

The 1-MHz input enters via J203. From this point, it is fed to a tuned isolation amplifier (Q205/T205) located at the front of the unit on the bottom board. The output link on T205 connects to a pulse shaper circuit at the front of the top board.

The pulse shaper is comprised of the circuit involving Q101 and Q102, which are connected as an emitter-coupled clipper. Q102 is biased at 9 V and the 1-MHz signal from Q205 is fed to the base of Q101. This arrangement results in a 1-MHz square-wave current in each collector. The current in Q102 is fed to L101 which rings at its self-resonant frequency for one-half cycle (or until CR101 conducts, dissipating the energy in L101). Waveforms representative of the action of this circuit appear in Figure DD-12 and DD-13.

The resulting pulse is amplified in Q103 and another self-resonant choke, L102, shortens the spike further. This spike triggers the monostable blocking oscillator Q104/T101, and the blocking oscillator cycles once for each pulse received from Q103. The amplitude of the blocking oscillator is controlled by R109. Waveforms of these various parts of the circuit can be seen in Figures DD-14 and DD-15.

The load for the blocking oscillator consists of R110 and a snap-off diode, CR102, at the end of a coaxial delay line, Z101. When the blocking oscillator turns on negatively, CR102 turns on also, since its anode is effectively grounded for low frequencies, through delay lines Z102 and Z104. While it is conducting, a certain amount of charge is stored in the diode junction so that, when the blocking oscillator turns off abruptly, the diode retains its high conductance (because of the mobile carriers in its junction)

until the charge is swept out. Then, as the stored charge is abruptly exhausted, the diode turns off in a fraction of a nanosecond (Figure DD-14).

This sharp transition creates a negative pulse at the anode of CR102, which propagates down Z102 until it reaches the junction of Z102, Z103, and Z104. The reflection of this pulse, from the end of shorted clipping line Z104, returns to the junction of the three delay lines with reversed phase, canceling the input. The electrical length of Z104 thus determines the width of the pulse. The pulse travels down Z103 to the sampling gate.

Delay lines Z101 and Z104 consist of the four sections of preformed, semirigid, 50-ohm coaxial cable mounted on the top board.

DD-2.3 DIGIT OSCILLATOR.

The Digit Oscillator, Q201, is part of the bottom etched-circuit assembly; it is Colpitts connected, with grounded base and transformer-coupled output. The oscillator is tuned by circuits that change the bias on varactors CR201 and CR202, both for digit selection and phase lock. CR203 is in series with the varactor bias and is connected to cancel the contact potential of the varactor, so changes in varactor contact potential with temperature do not affect the oscillator frequency. Temperature coefficients of C203 and C204 compensate the remaining drifts of the oscillator. The varactors are in parallel for ac control (+18 Vdc to AT228) and in series for the rf (across L204).

The output of the oscillator is taken from T201 and fed through the low-pass filter, L205/L206 and C207 through C211, to remove any harmonics.

DD-2.4 FREQUENCY-SELECTION CIRCUITS.

The digit oscillator frequency tuning of the module is accomplished electronically, controlled by electrical contact closures to ground. In the case of manual operation, the contact closures are made by S401 through R425. (R425 represents the impedance in the FP-4 Filter Plug when remote operation is used.) When remote operation is selected, S401 grounds PL401-14 and the contact closures are made from the appropriate PL401 terminal (1 through 12) to PL401-14. Making contact closures to PL401-14 instead of chassis ground insures that the module will ignore remote programming information when manual operation is selected.

The frequency-selecting element consists of a voltage divider connected between the output of the dc amplifier (paragraph DD-2.7) at +6-Vdc bias, and +18 Vdc. (See Figure DD-8) with R_1 fixed, as R_2 is varied, the varactor bias varies according to the expression

$$E_T = \frac{12 R_2}{R_1 + R_2}$$

so as $R_2 \rightarrow \infty$, $E_T \rightarrow 12$ and as $R_2 \rightarrow 0$, $E_T \rightarrow 0$.

Thus, the selection of R_2 controls the varactor bias and thereby determines the digit-oscillator frequency.



The voltage divider, in addition to providing the bias change for the rough tuning of the digit oscillator, also acts upon the phase-error information coming from the dc amplifier. This arrangement is provided so that, as the varactor bias is lowered (which increases the voltage sensitivity of the varactors), the loop gain of the phase-lock loop is held relatively constant. Without this compensation, the phase-lock loop would self-oscillate at the lower frequencies, due to the rise in sensitivity of the varactor $\Delta C/\Delta V$ at low varactor voltages.

In the module, 11 sets of resistors combine to provide 11 separate values for R_2 , preselected to give the 12 desired output frequencies.

NOTE

One "value" of R_2 is ∞ , so no selector is required. This corresponds to the highest frequency selected.

Each of the 11 resistors consist of one fixed resistor and one potentiometer, mounted on the rear-most etched board beneath connector PL401. The resistors are selected by transistor switches Q401 to Q411, one at a time. A transistor is turned on by grounding its base through the appropriate resistor R412 - R422, which causes the transistor to saturate and connect the end of the "tuning" resistor to +18 Vdc through its collector circuit.

The action is the same whether the grounding operation occurs at the switch or plug, since S401 and PL401 are in parallel for digit selection.

DD-2.5 AMPLIFIER CIRCUIT.

The bottom board contains three amplifiers, one at 1 MHz and two at the digit-oscillator frequency. The 1-MHz input amplifier, Q205, is a common-emitter amplifier with tuned output. It is driven by 1 MHz entering from the sandwich deck at J203. The tuned output transformer of this stage (T205) supplies 1 MHz to the top etched-board assembly.

Two high-frequency rf amplifiers are used in the module. They are driven in parallel by the digit oscillator, one providing the output signal at J202, and the other driving the sampler in the phase-lock loop.

The two are essentially identical, transformer-coupled, common-base amplifiers, the output amplifier having one stage and the buffer amplifier having two stages. In the buffer amplifier the transistors are in series for dc power, cutting down on power drain and simplifying bypass problems. The transformers are 2:1 step-down, giving a 4:1 impedance transformation. The gain per stage is approximately 6 dB. Each amplifier has a high forward-to-reverse gain ratio, which effectively prevents disturbances at their outputs from affecting the digit oscillator.

The amplifier in the servo-loop consists of Q202/T202 and Q203/T203. R206, the adjustable element in the input attenuator of the amplifier, controls loop gain by adjustment of the rf drive to the sampler.

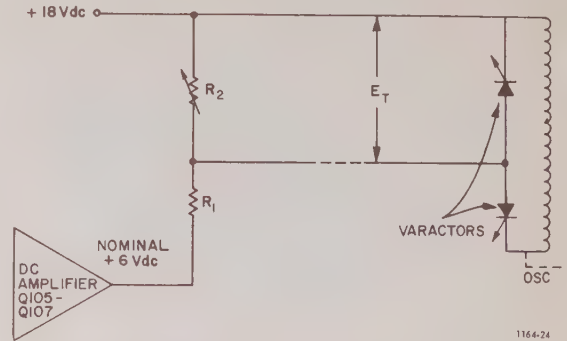


Figure DD-8. Elementary frequency-selecting circuit, RDI-4.

The output amplifier is comprised of Q204/T204. R216 adjusts the drive to this stage, setting the rf output level.

DD-2.6 SAMPLER AND DC AMPLIFIER SYSTEM.

DD-2.6.1 GENERAL.

The top board contains the balance of the circuitry in the servo loop, including the pulse generator described in paragraph DD-2.2. The remainder of the circuits in the system include the sampler dc control amplifier, described in the following paragraphs.

DD-2.6.2 SAMPLER.

The sampler is a normally closed gate circuit. This gate is "opened" on command from the 1-MHz repetition-rate pulse from the pulse generator described in paragraph DD-2.2. The gate remains open only for the duration of the pulse, 1 ns. When the gate is open, the impedance between AT106 and the top of C108 is very low; otherwise it is very high.

The gating function is performed by the two high-speed sampling diodes, CR103 and CR104. The circuit is arranged so that the diodes are normally back biased by the voltage divider, R114, R115 and R116. A sampling pulse advancing down Z103 is converted by T102 to balanced drive for the sampler. The current in this pulse turns the diodes on through C106 and C107. The self-inductance of T103 prevents the transformer from short circuiting this very short-duration pulse. The digit-oscillator signal, however, fed in parallel to the windings of T103, appears directly on capacitors C106 and C107. Thus, when CR103 and CR104 conduct, the path through these diodes in parallel is the primary circuit between AT106 (the feed-point for the rf) and C108, the sample-hold capacitor. C108 therefore charges very rapidly to the instantaneous rf level.

When the gate is closed, holding capacitor C108 is thus left with a charge proportional to the instantaneous level of the rf at AT106, at the time the last sample was taken. C108, when the gate is closed, is loaded only by a very high impedance determined by the Q105 bias current and the reverse leakage current

through the diodes; it therefore discharges very slowly. The dc component of current in these two discharging loads is cancelled by a current fed to this point of the circuit by R124, a 2.7 M Ω resistor. This current is determined by the setting of R113 "Sample Hold Slope", which is adjusted so that the value of the sample charge in C108 (and the voltage across C108) is retained with minimum change, until replaced by the next sample, 1 μ s later.

DD-2.6.3 DC AMPLIFIERS.

The dc amplifier in the servo loop consists of Q105 and Q106, connected as a differential amplifier, and Q107. The over-all voltage gain with feedback is about 8 and is designed for zero offset and minimum drift. This amplifier provides a low source impedance for the frequency selector circuits, minimum loading on C108, and additional loop gain.

A 1-MHz notch filter (consisting of L106 and C111) is in series with the control line of the oscillator, so that any 1-MHz component appearing at the output of the dc amplifier does not appear at the digit-oscillator control input. Such a signal, if present, would create 1-MHz fm sidebands on the output of the module.

DD-2.7 RECAPITULATION - OSCILLATOR CONTROL.

In the preceding paragraphs, the individual parts of the oscillator locking system have been described. These elements make up the oscillator locking scheme, to maintain the selected frequency outputs at strict multiples of the incoming 1-MHz signal.

In review, the rf output of the digit oscillator is sampled at a 1-MHz rate controlled by the 1-MHz input. If the frequency of the digit oscillator is exactly 40 times the input signal (1-MHz), exactly 40 cycles of the 40 MHz will occur between samples and the value of the sample will be exactly the same each time. Its value will depend on the phase and amplitude of the 40-MHz signal. Likewise, if the rf is exactly 49 MHz, 49 cycles will occur between samples and the value at the instant each sampling pulse occurs will again be the same as at the previous one. The output of the sampler, since the sample is "held" by C108, will therefore be dc, if the frequency is any exact multiple of the 1-MHz sampling rate. Thus, the sampling system can make no distinction as to which multiple is being observed, only that it is, in fact, a multiple of the sampling rate.

The output of the dc amplifier is connected via the frequency-selector circuits to the digit-oscillator varactors, CR201 and CR202, and corrects the digit-oscillator frequency as required to establish the integral relationship of this frequency to 1 MHz at a multiple as chosen by the position of switch S401, or through the remote plug PL401.

Typical switching behavior of the synthesizer output frequency, as a result of the action of this programmable digit unit, is shown in Figure DD-9.



Figure DD-9. Switching behavior of the RDI-4 module in response to remote control through the FP-4 plug. Trace A shows the correction time that occurs in the phase-detector dc-amplifier output, as a result of the programming signal, trace B. The ultimate change in the synthesizer output (from 1 MHz to 0 MHz) is shown in trace C. The horizontal time scale is 50 μ s/cm.

Details of the frequency-correcting action of this servo loop are as follows. Unless the oscillator frequency is exactly correct, each sample will have a different voltage than the last, due to the phase drift of the input relative to the pulses. If the frequency is too low, each succeeding sample will have a higher voltage than the last (assuming the samples are being taken on the negative slope of the sinewave). This will place a higher voltage on the varactors, which lowers their capacitance and raises the frequency of the oscillator. In a like manner, if the frequency is too high, a lower voltage will appear at the output of the sampler from one sample to the next, which will reduce the varactor voltage and lower the oscillator frequency. Thus, in equilibrium, the voltage from the sampler is determined by the phase of the oscillator with respect to the sampling pulses, and adjusts itself continuously, as necessary, to maintain the oscillator frequency at an exact multiple of the sampling frequency.

DD-2.8 LAMP-CONTROL CIRCUIT.

This circuit is mounted on the front etched-circuit board of the module and functions to extinguish the pilot light in front of the digit dial, if the reference signal is present but the oscillator fails to lock. This function is accomplished by sensing for the presence of ac on the oscillator control line. If ac is present, this implies that either the oscillator is not locked or the phase-lock loop is self-oscillating, either condition being a malfunction. Ac amplifier Q301 will amplify any ac present on the oscillator control line. If any ac is present, it is detected by CR301 and CR302. This changes the bias on Q302, driving Q302 out of conduction. If this occurs, the voltage on the lamp-control pin drops to zero and the lamp-control transistor on the chassis lamp-panel assembly cuts off and extinguishes the lamp. (Refer to Section BB, on the chassis, for discussion of the operation of this circuit.)



SECTION DD-3

SERVICE AND MAINTENANCE

DD-3.1 INTRODUCTION.

If the system fault-localization procedure of Section 5 of the front portion of the manual indicates possible malfunction of the RDI-4 unit, the most positive verification of this suspicion is the substitution of another RDI-4 unit.

NOTE

Temporary substitution of a DI-4 unit would also be helpful if the failure was not related strictly to the remote frequency selection circuits.

If this step restores the instrument to normal operation, the defective unit should, if possible, be returned to the General Radio Company for service and repair, especially if it is within the two-year warranty.

Since there is but one such unit per synthesizer, and since service spares may not be available, it will not always be possible to make the substitution as outlined above. Where this is not possible, selected tests and a few alignment steps may be made in the field.

The synthesizer cannot operate without a properly functioning DI-4 or RDI-4 module.

CAUTION

Many alignment procedures require the use of special test fixtures and cannot be accomplished in the field.

A thorough knowledge of the principles of operation, and all of the circuit arrangements by which the desired operation is achieved, is essential before RDI-4 module service is attempted.

DD-3.2 TEST EQUIPMENT.

Recommended test equipment is listed and described in Table DD-2; equivalent equipment may be substituted.

DD-3.3 TROUBLE ANALYSIS.

CAUTION

Turn synthesizer power off during set-up changes to avoid accidental short circuits.

TABLE DD-2
TEST EQUIPMENT

<i>Function</i>	<i>Equipment Recommended*</i>	<i>Minimal Characteristics</i>
Electronic Voltmeter (VTVM)	GR 1806 with 1806-P1 probe	2% accuracy; ac and dc capabilities
Dual-Trace Oscilloscope	Tektronix 543 (with C/A plug-in and P6006 10x passive probe)	20 MHz, 0.5 V/cm with 8 pF (or less) probe capacitance
Sampling Oscilloscope	Tektronix 661 with 4S1 and 5T1A plug-ins and P6032 CR Probe	1000 MHz; high-impedance probe
Digital Counter	GR 1192-B	Up to 50 MHz with 7-place readout
Standard Sweep Frequency Generator	GR 1025	Calibration accuracy — 0.5%

*Or equivalent

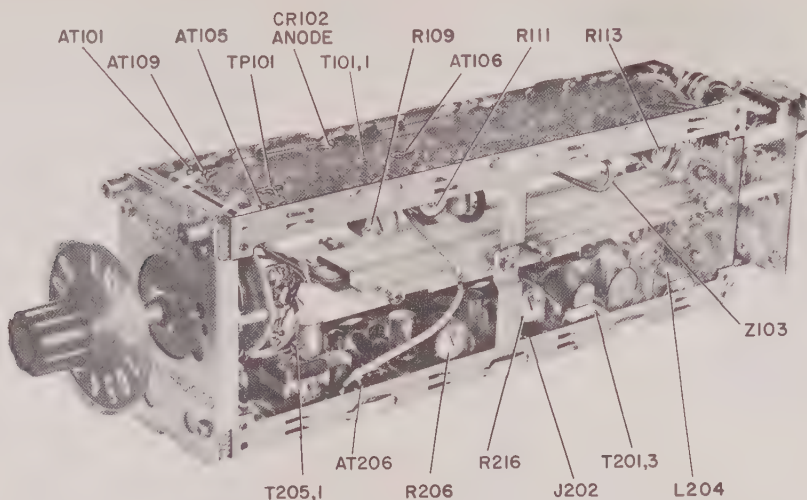


Figure DD-10. RDI-4 interior test points and adjustments. Top right oblique view.

DD-3.3.1 GENERAL.

Remove the instrument from the cabinet, remove the RDI-4 unit, and the DI unit in station II. For procedural details refer to Section 5 (in the front portion of the manual). Release the 6 screws in the sides and slide the cover off the unit. Reinstall the module (less cover) in the chassis and install the spare DI-1 Bridging Unit (supplied) in station II.

Set the RDI-4 digit dial to 5, set the DI dials in any position and apply power to the synthesizer.

Refer to Figures DD-10 and DD-11 for the locations of test points and secondary adjustments referred to in procedures that follow. See also Figure DD-21, the over-all schematic diagram.

The most common symptoms of failure within the RDI-4 will be the generation of improper frequencies or the failure to give any output whatever. Procedures that follow will give assurance that the difficulty is in this module and not in some other unit and will facilitate fault isolation to the detail-part level.

DD-3.3.2 POWER INPUT.

With the VTVM, look for $+18 \pm 0.2$ Vdc at AT101 on the top circuit board. If the indication is abnormal, look at J201 at the bottom circuit board. If the voltage is correct at J201, but is incorrect elsewhere, the malfunction is in the RDI-4. If J201 indicates an incorrect voltage, check the power supply and chassis-power distribution in the sandwich deck (refer to Sections BB and GC).

DD-3.3.3 1-MHz CIRCUITS.

With the oscilloscope, look for the 1-MHz input from the AFS module at J203. If the input signal is missing, distorted, or less than 0.7 V, rms, check the Main Frame (Section BB) and the AFS (Section CB). This test is independent of the settings of the synthesizer front-panel controls.

If the 1 MHz is normal, observe the 1 MHz at pin 5 of T205. If no 1 MHz is present, the 1-MHz

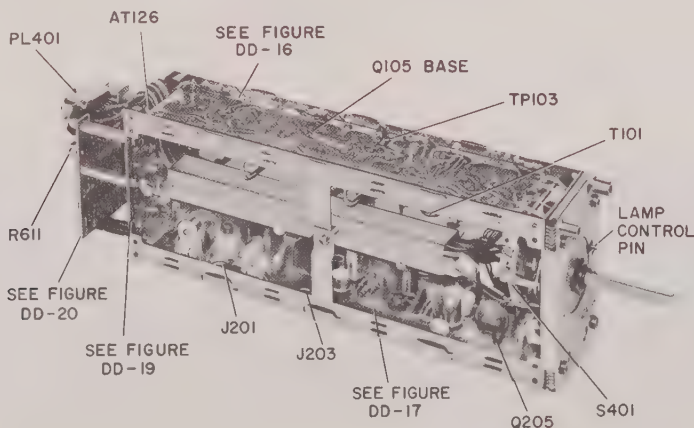


Figure DD-11. RDI-4 interior test points and adjustments. Top left oblique view.



buffer stage Q205 is inoperative. Next, observe the waveform at TP101 (top board, foil side). It should appear as in Figure DD-12. T205 may be adjusted to maximize this signal. If no signal is present, check the pulse clipper stage, Q101 and Q102, and the drive signal to Q101 (at AT105).

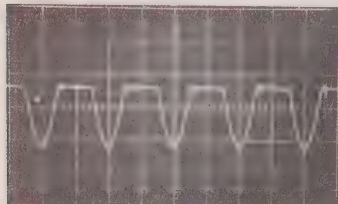


Figure DD-12. Waveform at TP101 (see Figure DD-10).

DD-3.3.4 PULSE CIRCUITS.

The simplest approach to isolate trouble in stages Q101-Q104 is to signal-trace the various waveforms until a defective circuit is located. Figures DD-13 (A and B) show the waveform at the collector of Q102, the input to the pulse amplifier; the output at the emitter of Q103 is shown at Figure DD-13 (C and D).

R109 controls the amplitude of the blocking-oscillator pulse, the waveform of which can be observed at the collector of Q104 (case).

CAUTION

Do not change the setting of R109 unless there is a strong reason to do so, since a change in pulse amplitude can upset the sampler balance.

The sampling oscilloscope is needed for the remainder of the pulse circuits. Figure DD-14 (A) shows the output of the blocking oscillator at pin 1, T101, (use Figure DD-16 to find the test point). Figure DD-14 (B) shows the waveform at the anode of CR102. CR102, a plug-in unit, is selected to give the stored-charge, snap-off characteristics necessary to speed up the blocking-oscillator pulse. The waveform of the final pulse is seen at TP103, Figure DD-14 (C).

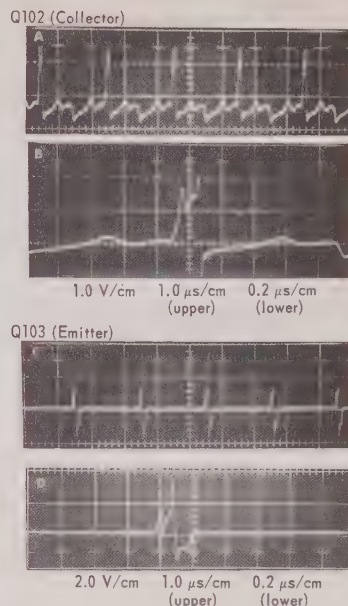


Figure DD-13. Typical input and output waveforms for the servo-circuit pulse amplifier (see Figure DD-16).

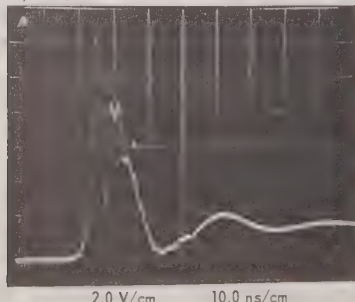
DD-3.3.5 RF CIRCUITS.

A rough estimate of the performance of the 39 to 50 MHz sections of the module can be made by signal tracing with the oscilloscope and VTVM (see Figure DD-10).

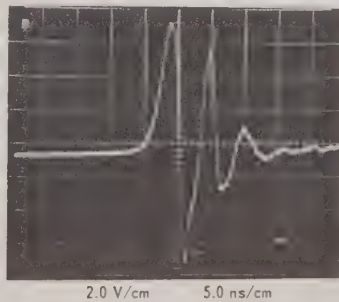
A frequency equal to the digit-output frequency should be found progressively at the following points: pin 3, T201, at approximately 0.5 V, rms; J202 (rf output) 0.3 V, rms, (adjustable by R216); and AT206 and AT106 at about 50 - 100 mV, rms, depending on the factory setting of servo control loop-gain (see Figure DD-17 for test points).

If gain control R206 or other elements in the servo loop become faulty, or misadjusted, the servo-control circuit may oscillate and inhibit normal phase-

T101, Pin 1



CR102 (Anode)



TP103

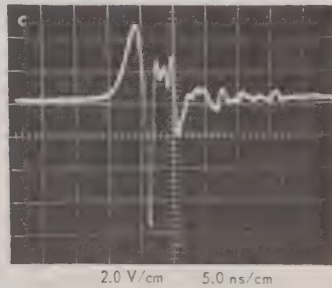


Figure DD-14. Sampling oscilloscope waveforms typical of servo-circuit blocking-oscillator performance.

lock operation. Figure DD-15 is indicative of this symptom, as seen at AT109. CCW adjustment of R206 should stop this condition, but usually insufficient capture range results. If this adjustment is ineffective the unit should be returned to General Radio Company for repair.

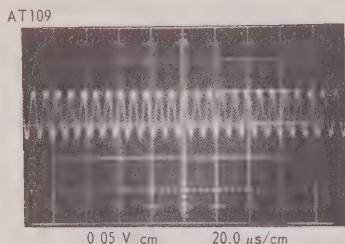


Figure DD-15. Typical waveform at AT109, indicating self-oscillation resulting from an incorrect setting of R206, the digit oscillator control-loop gain control.

DD-3.3.6 DC AMPLIFIER.

Table DD-3 includes the voltages that should be obtained in the dc amplifier circuits.

TABLE DD-3
DC VOLTAGE INDICATIONS

Transistor	Emitter	Base	Collector
Q101	9.8 V	9.2	0
Q102	9.8 V	9.2	0
Q103	0	0	17.0
Q104	0	-0.6	6.0
Q105	6.6	6.0	1.3
Q106	6.6	6.0	0
Q107	0.65	1.3	6.0
Q201	2.2	2.8	18.0
Q202	2.8	3.6	9.7
Q203	10.2	10.8	16.8
Q204	6.3	7.0	15.0
Q205	10.0	9.4	0
Q301	5.6	6.0	11.0
Q302	0.65	0.45	0.6
Q401* ON	18.0	17.0	**
Q402 thru OFF Q411	18.0	18.0	**

NOTES:

*Q400 series transistors are switches whose bias voltages are determined by their state, on or off. One transistor is on at a time, depending on the digit selected. For digit "0" all transistors are off. If digit "2" is selected, Q402 is on; if digit "3" is selected, Q403 is on, etc.

**Collector voltages will all be the same, and will range from *6 V to about *17 V, depending on digit selected.

DD-3.3.7 NOTCH FILTER.

Remove Q104 to stop the pulse generator. Set the digit dial to "R." Connect the VTVM (dc mode) to

AT126 and adjust R113 to a 6.0 Vdc indication,

Connect the signal generator to the base of Q105, through a 0.01-μF coupling capacitor. Sweep through 1 MHz at 0.1 V, rms, and with the VTVM (ac mode), observe the voltage at AT126. The ac voltage output of the amplifier should go through a minimum at 1 MHz. If the notch can't be found, the unit must be returned to General Radio for realignment.

DD-3.3.8 FREQUENCY SELECTOR AND CONTROL CIRCUITS.

If one or a few digits fail to program properly but the unit functions normally otherwise, the trouble may be in the selector circuits. If any digit gives "0" instead of the correct value, trace through the wiring for opens between PL401, S401, and the appropriate switching transistor Q401-Q411. If one digit, other than "0", gives the same value in "0" and its own place, but the other frequencies are wrong, check for shorts in the circuits associated with the digit in question.

Note that digit "0" is set with L204 while all remaining digits are set with one of the potentiometer controls, R601-R611.

CAUTION

These controls should not be moved—their proper alignment requires a special test cover.

Access to the two rear boards for component replacement is facilitated by loosening the rear board and PL401, and swinging them out of the way.

DD-3.4 DC VOLTAGE CHECKS.

The procedures in paragraph DD-3.3 should narrow the search for circuit defects to a circuit function consisting of one or, at the most, a few stages. As a further aid to pinpointing the defective part, the information on dc voltage readings is presented in Table DD-3.

DD-3.5 REPAIRS AND REPLACEMENT.

Replace defective detail parts (with frequency-insensitive functions) to correct deficiencies indicated by the trouble-analysis procedures.

CAUTION

Replacement of frequency-determining parts will require realignment that cannot be accomplished without special test fixtures.

Figures DD-16 through DD-20 show the physical layout of the parts on the various etched-circuit boards, to speed positive identification. The reference designators for the parts shown on the boards are the same as those used in the over-all schematic diagram, Figure DD-21, and in the parts list at the end of this section.

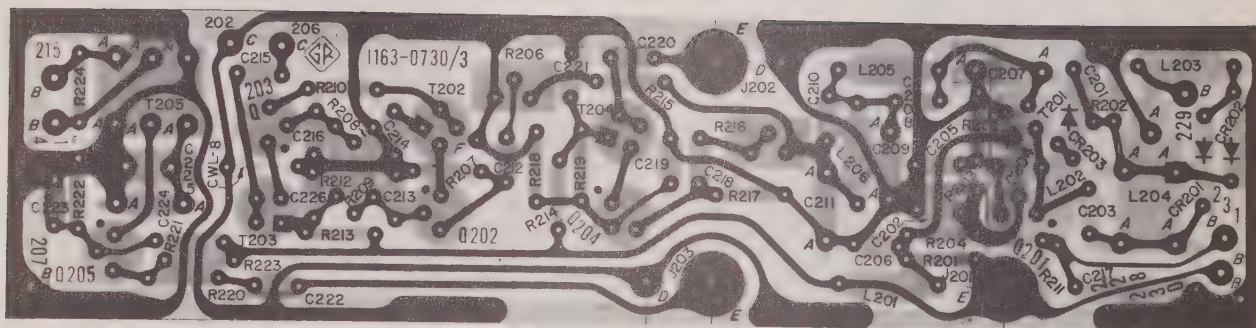


Figure DD-16. Etched-circuit board assembly (top) for RDI-4 (P/N 1163-2742).

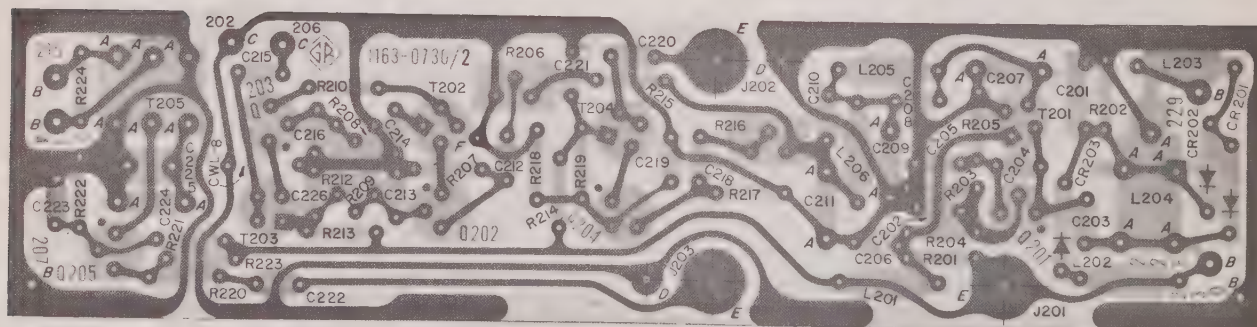


Figure DD-17. Etched-circuit board assembly (bottom) for RDI-4 (P/N 1163-2732).

NOTE: The number appearing on the foil side is not the part number.
The dot on the foil at the transistor socket indicates the collector lead.

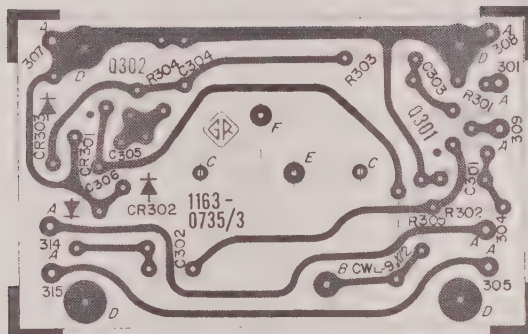


Figure DD-18. Etched-circuit board assembly (front) for RDI-4 (P/N 1163-2735).

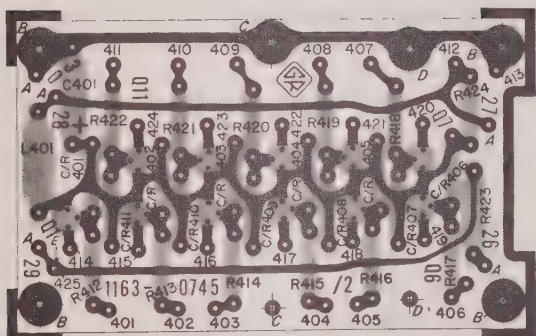


Figure DD-19. Etched-circuit board assembly (rear 1) for RDI-4 (P/N 1163-2746).

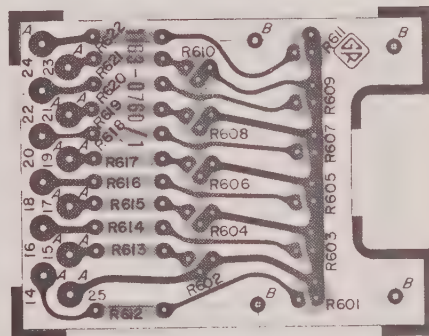


Figure DD-20. Etched-circuit board assembly (rear 2) for RDI-4 (P/N 1163-2760).

Difference Data

Units with serial numbers below 135 do not have C401 through C411. Also, the values for R401 through R411 are 160 k Ω .

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C101	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	CC61, 0.01 μ F +80-20%	5910-974-5697
C102	Ceramic, 0.0047 μ F +80-20%	4405-2479	72982	801, 0.0047 μ F +80-20%	
C103	Ceramic, 470 pF $\pm$ 10% 500 V	4405-1478	72982	801, 470 pF $\pm$ 10%	
C104	Electrolytic, 1 μ F $\pm$ 10% 35 V	4450-4301	56289	150D105X9035A2	
C105	Ceramic, 0.02 μ F +80-20% 50 V	4402-3200	01121	35-203W	5910-974-5698
C106	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	CC61, 0.01 μ F +80-20%	5910-974-5697
C107	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	CC61, 0.01 μ F +80-20%	5910-974-5697
C108	Ceramic, 16 pF $\pm$ 5% 500 V (NPO)	4410-0165	72982	811, 16 pF $\pm$ 5%	
C109	Ceramic, 22 pF $\pm$ 5% 500 V (NPO)	4410-0225	72982	811, 22 pF $\pm$ 5%	
C110	Electrolytic, 2.2 μ F $\pm$ 20% 20 V	4450-4500	56289	150D225X0020A2	5910-976-4604
C111	Mica, 243 pF $\pm$ 1% 500 V	4710-0424	14655	22A, 243 pF $\pm$ 1%	
C201	Ceramic, 0.22 μ F $\pm$ 20% 25 V	4400-2052	80183	5C13, 0.22 μ F $\pm$ 20%	5910-974-5694
C202	Ceramic, 0.0022 μ F +80-20% 500 V	4405-2229	72982	801, 0.0022 μ F +80-20%	5910-081-0584
C203	Ceramic, 24 pF $\pm$ 5% 500 V (N750)	4417-0245	72982	801, 24 pF $\pm$ 5%	
C204	Ceramic, 24 pF $\pm$ 5% 500 V (N750)	4417-0245	72982	801, 24 pF $\pm$ 5%	
C205	Ceramic, 180 pF $\pm$ 5% 500 V	4404-1185	72982	831, 180 pF $\pm$ 5%	5910-952-8403
C206	Ceramic, 0.0022 μ F +80-20% 500 V	4405-2229	72982	801, 0.0022 μ F +80-20%	5910-081-0584
C207	Ceramic, 47 pF $\pm$ 5% 500 V (N750)	4417-0475	72982	801, 47 pF $\pm$ 5%	
C208	Ceramic, 39 pF $\pm$ 5% 500 V (N750)	4417-0395	72982	801, 39 pF $\pm$ 5%	
C209	Ceramic, 91 pF $\pm$ 5% 500 V (N750)	4417-0915	72982	801, 91 pF $\pm$ 5%	
C210	Ceramic, 13 pF $\pm$ 5% 500 V (N750)	4417-0135	72982	801, 13 pF $\pm$ 5%	
C211	Ceramic, 62 pF $\pm$ 5% 500 V (N30)	4411-0625	72982	831, 62 pF $\pm$ 5%	
C212					
thru C216	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C217	Electrolytic, 47 μ F $\pm$ 20% 20 V	4450-5712	37942	MTP, 47 μ F $\pm$ 20%	
C218					
thru C221	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C222	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	CC61, 0.01 μ F +80-20%	5910-974-5697
C223	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	CC61, 0.01 μ F +80-20%	5910-974-5697
C224	Ceramic, 91 pF $\pm$ 5% 500 V (N750)	4417-0915	72982	801, 91 pF $\pm$ 5%	
C225	Mica, 508 pF $\pm$ 1% 300 V	4710-0579	14655	22A, 508 pF $\pm$ 1%	
C226	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C301					
thru C306	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	CC61, 0.01 μ F +80-20%	5910-974-5697
C401					
thru C411	Ceramic, 100 pF +80-20% 50 V	4404-1109	72982	831, 100 pF +80-20%	
C412	Electrolytic, 2.2 μ F $\pm$ 20% 20 V	4450-4500	56289	150D225X0020A2	5910-976-4604
DIODES					
CR101	Semiconductor, type 1N3604	6082-1001	24446	1N3604	
CR102	Semiconductor, type 1N3604	6082-1001	24446	1N3604	5905-995-2199
CR103	Semiconductor, special	1164-2010	24655	1164-2010	5905-995-2199
CR104	Semiconductor, special	1164-2010	24655	1164-2010	
CR105	Semiconductor, type 1N3604	6082-1001	24446	1N3604	
CR201	Semiconductor, type 1N5148 (varactor)	6084-1016	00434	1N5148	5905-995-2199
CR202	Semiconductor, type 1N5148 (varactor)	6084-1016	00434	1N5148	
CR203	Semiconductor, type 1N3604	6082-1001	24446	1N3604	
CR301	Semiconductor, type 1N191	6082-1008	93916	1N191	5905-995-2199
CR302	Semiconductor, type 1N191	6082-1008	93916	1N191	5961-296-3360
CR303	Semiconductor, type TIS6	6082-1016	24446	1N645	5961-296-3360
					5961-087-6047
RESISTORS					
R101	Composition, 120 Ω $\pm$ 5% 1/4 W	6099-1125	75042	BTS, 120 Ω $\pm$ 5%	
R102	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R103	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R104	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R105	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R106	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R107	Composition, 820 Ω $\pm$ 5% 1/4 W	6099-1825	75042	BTS, 820 Ω $\pm$ 5%	
R108	Composition, 560 Ω $\pm$ 5% 1/4 W	6099-1565	75042	BTS, 560 Ω $\pm$ 5%	
R109	Potentiometer, composition, 2 k Ω $\pm$ 5%	6053-1105	80294	3307W, 2 k Ω $\pm$ 5%	
R110	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	
R111	Potentiometer, composition, 100 Ω $\pm$ 20%	6049-0740	75042	156-2	
R112	Composition, 330 k Ω $\pm$ 5% 1/4 W	6099-4335	75042	BTS, 330 k Ω $\pm$ 5%	
R113	Potentiometer, composition, 100 k Ω $\pm$ 20%	6040-1000	01121	FWC, 100 k Ω $\pm$ 20%	5905-958-7949
R114	Film, 11 k Ω $\pm$ 1% 1/8 W	6250-2110	75042	CEA, 11 k Ω $\pm$ 1%	5905-681-4941

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
RESISTORS (Cont)					
R115	Film, 2 k Ω $\pm$ 1% 1/8 W	6250-1200	75042	CEA, 2 k Ω $\pm$ 1%	5905-577-6614
R116	Film, 4.99 k Ω $\pm$ 1% 1/8 W	6250-1499	75042	CEA, 4.99 k Ω $\pm$ 1%	
R117	Composition, 27 k Ω $\pm$ 5% 1/4 W	6099-3275	75042	BTS, 27 k Ω $\pm$ 5%	5905-683-3838
R118	Film, 10 k Ω $\pm$ 1% 1/8 W	6250-2100	75042	CEA, 10 k Ω $\pm$ 1%	5905-883-4847
R119	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9992
R120	Composition, 22 k Ω $\pm$ 5% 1/4 W	6099-3225	75042	BTS, 22 k Ω $\pm$ 5%	5905-687-0002
R121	Composition, 6.8 k Ω $\pm$ 5% 1/4 W	6099-2685	75042	BTS, 6.8 k Ω $\pm$ 5%	5905-686-9997
R122	Film, 4.99 k Ω $\pm$ 1% 1/8 W	6250-1499	75042	CEA, 4.99 k Ω $\pm$ 1%	
R123	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	5905-681-9969
R124	Composition, 2.7 M Ω $\pm$ 5% 1/4 W	6099-5275	75042	BTS, 2.7 M Ω $\pm$ 5%	
R125	Composition, 47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R201	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R202	Composition, 33 k Ω $\pm$ 5% 1/4 W	6099-3335	75042	BTS, 33 k Ω $\pm$ 5%	
R203	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6422
R204	Composition, 5.6 k Ω $\pm$ 5% 1/4 W	6099-2565	75042	BTS, 5.6 k Ω $\pm$ 5%	5905-691-0195
R205	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6422
R206	Potentiometer, 100 Ω $\pm$ 20% 1/4 W	6049-0740	75042	156-2	
R207	Composition, 390 Ω $\pm$ 5% 1/4 W	6099-1395	75042	BTS, 390 Ω $\pm$ 5%	
R208	Composition, 1.8 k Ω $\pm$ 5% 1/4 W	6099-2185	75042	BTS, 1.8 k Ω $\pm$ 5%	5905-688-3738
R209	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	5905-681-9969
R210	Composition, 47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R211	Composition, 68 Ω $\pm$ 5% 1/4 W	6099-0685	75042	BTS, 68 Ω $\pm$ 5%	
R212	Composition, 2.7 k Ω $\pm$ 5% 1/4 W	6099-2275	75042	BTS, 2.7 k Ω $\pm$ 5%	
R213	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R214	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R215	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R216	Potentiometer, 200 Ω $\pm$ 20% 1/4 W	6049-0745	75042	156-2	
R217	Composition, 680 Ω $\pm$ 5% 1/4 W	6099-1685	75042	BTS, 680 Ω $\pm$ 5%	
R218	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9992
R219	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9992
R220	Composition, 680 Ω $\pm$ 5% 1/4 W	6099-1685	75042	BTS, 680 Ω $\pm$ 5%	
R221	Composition, 15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R222	Composition, 15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R223	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	5905-681-9969
R224	Composition, 33 Ω $\pm$ 5% 1/4 W	6099-0335	75042	BTS, 33 Ω $\pm$ 5%	
R301	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240
R302	Composition, 820 Ω $\pm$ 5% 1/4 W	6099-1825	75042	BTS, 820 Ω $\pm$ 5%	
R303	Composition, 680 Ω $\pm$ 5% 1/4 W	6099-1685	75042	BTS, 680 Ω $\pm$ 5%	
R304	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9992
R305	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R401					
thru	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R411					
R412					
thru	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R422					
R423	Film, 1.5 k Ω $\pm$ 1% 1/8 W	6250-1150	75042	CEA, 1.5 k Ω $\pm$ 1%	5905-581-6913
R424	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R425	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6422
R601	Potentiometer, 10 k Ω $\pm$ 30%	6049-0109	80740	34331210	
R602	Potentiometer, 5 k Ω $\pm$ 30%	6049-0108	98474	597040	
R603	Potentiometer, 2 k Ω $\pm$ 30%	6049-0107	98474	597035	
R604	Potentiometer, 2 k Ω $\pm$ 30%	6049-0107	98474	597035	
R605	Potentiometer, 1 k Ω $\pm$ 30%	6049-0106	98474	62PRIK	
R606	Potentiometer, 500 Ω $\pm$ 30%	6049-0105	98474	62TR500	
R607	Potentiometer, 500 Ω $\pm$ 30%	6049-0105	98474	62TR500	
R608					
thru	Potentiometer, 200 Ω $\pm$ 30%	6049-0104	98474	597020	
R611					
R612	Composition, 6.8 k Ω $\pm$ 5% 1/4 W	6099-2685	75042	BTS, 6.8 k Ω $\pm$ 5%	5905-686-9997
R613	Composition, 2.7 k Ω $\pm$ 5% 1/4 W	6099-2275	75042	BTS, 2.7 k Ω $\pm$ 5%	
R614	Composition, 1.8 k Ω $\pm$ 5% 1/4 W	6099-2185	75042	BTS, 1.8 k Ω $\pm$ 5%	5905-688-3738
R615	Composition, 1.2 k Ω $\pm$ 5% 1/4 W	6099-2125	75042	BTS, 1.2 k Ω $\pm$ 5%	
R616	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6422
R617	Composition, 750 Ω $\pm$ 5% 1/4 W	6099-1755	75042	BTS, 750 Ω $\pm$ 5%	
R618	Composition, 560 Ω $\pm$ 5% 1/4 W	6099-1565	75042	BTS, 560 Ω $\pm$ 5%	
R619	Composition, 510 Ω $\pm$ 5% 1/4 W	6099-1515	75042	BTS, 510 Ω $\pm$ 5%	5905-801-8272
R620	Composition, 390 Ω $\pm$ 5% 1/4 W	6099-1395	75042	BTS, 390 Ω $\pm$ 5%	
R621	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R622	Composition, 270 Ω $\pm$ 5% 1/4 W	6099-1275	75042	BTS, 270 Ω $\pm$ 5%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
TRANSISTORS					
Q101	Type 2N3905	8210-1114	04713	2N3905	
Q102	Type 2N3905	8210-1114	04713	2N3905	
Q103	Type 2N708	8210-3089	24454	2N708	5961-954-6100
Q104	Type 2N2369	8210-1052	96214	2N2369	5960-682-7755
Q105	Type 2N3906	8210-1112	04713	2N3906	
Q106	Type 2N3906	8210-1112	04713	2N3906	
Q107	Type 2N3390	8210-1077	24454	2N5249	
Q201					
thru	Type 2N3563	8210-1066	07263	2N3563	
Q203					
Q204	Type 2N2218	8210-1028	96214	2N2218	5960-059-4464
Q205	Type 2N3905	8210-1114	04713	2N3905	
Q301	Type 2N3390	8210-1077	24454	2N5249	
Q302	Type 2N1305	8210-1305	96214	1N1305	5961-853-1079
Q401					
thru	Type 2N4125	8210-1125	04713	2N4125	
Q411					
MISCELLANEOUS					
Z101	Delay line, miniature rigid coaxial	1163-0201	24655	1163-0201	
Z102	Delay line, miniature rigid coaxial	1163-0202	24655	1163-0202	
Z103	Delay line, miniature rigid coaxial	1163-0203	24655	1163-0203	
Z104	Delay line, miniature rigid coaxial	1163-0204	24655	1163-0204	
L101	Inductor, Choke, iron core 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$	5950-951-9266
L102					
thru	Inductor, Choke, 1.5 μ H $\pm 10\%$	4300-1000	99800	1537, 1.5 μ H $\pm 10\%$	
L104					
L105	Inductor, Choke, iron core 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$	5950-951-9266
L106	Inductor, ferrite cup, adjustable	5000-2832	24655	5000-2832	
L201	Inductor, Choke, iron core 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$	5950-951-9266
L202	Inductor, Choke, iron core 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$	5950-951-9266
L203	Inductor, Choke, 4.7 μ H $\pm 10\%$	4300-1600	99800	1537-28, 4.7 μ H $\pm 10\%$	
L204	Inductor, adjustable, ceramic	1163-2100	24655	1163-2100	
L205	Inductor, Choke, iron core 0.10 μ H $\pm 10\%$	4300-6371	72259	07-1100-20-0-0	
L206	Inductor, Choke, iron core 0.15 μ H $\pm 10\%$	4300-6374	72259	07-07502-0-0-0	
L401	Inductor, Choke, Iron core 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$	5950-951-9266
J201					
thru	Jack, etched circuit, eyelet type	1160-6110	24655	1160-6110	
J203					
PL401	Plug, multipin, Amphenol 57-1014	4220-5307	02660	57-10140	
S401	Switch, rotary wafer	7890-4950	24655	7890-4950	
T101	Transformer, video, interstage	5000-2601	24655	5000-2601	
T102	Transformer, video, interstage	5000-2403	24655	5000-2403	
T103	Transformer, video, interstage	5000-2403	24655	5000-2403	
T201	Transformer, rf	5000-2402	24655	5000-2402	
T202					
thru	Transformer, video, interstage	5000-2403	24655	5000-2403	
T204					
T205	Transformer, ferrite cup, adjustable	5000-2835	24655	5000-2835	
ETCHED-CIRCUIT BOARD					
	Selector circuit assembly	1163-2746	24655	1163-2746	
	Control circuit assembly	1163-2760	24655	1163-2760	
	Servo circuit + Rail Asm.	1163-2742	24655	1163-2742	
	Rf circuit+ Rail Asm.	1163-2732	24655	1163-2732	
	Lamp control circuit assembly	1163-2735	24655	1163-2735	
	Knob + dial assembly	1163-1850	24655	1163-1850	

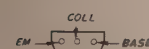
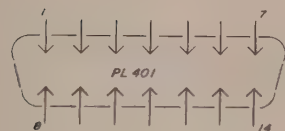
- NOTE UNLESS SPECIFIED
- 1 POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE
 - 2 CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK
 - 3 REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM
 - 4 RESISTORS 1/4 WATT
 - 5 RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
 - 6 CAPACITANCE VALUES ONE AND OVER IN PICOFARADS LESS THAN ONE IN MICROFARADS
 - 7 KNOB CONTROL
 - 8 SCREWDRIVER CONTROL
 - 9 AT ANCHOR TERMINAL
 - 10 TP TEST POINT



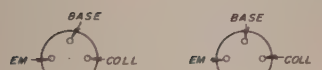
S401 SHOWN IN DIAL POSITION "R"



DIAL



Q101, Q102, Q105, Q106
Q205, Q401, Q402
Q403, Q404, Q405
Q406, Q407, Q408
Q409, Q410, Q411



Q103, Q104, Q204
Q302

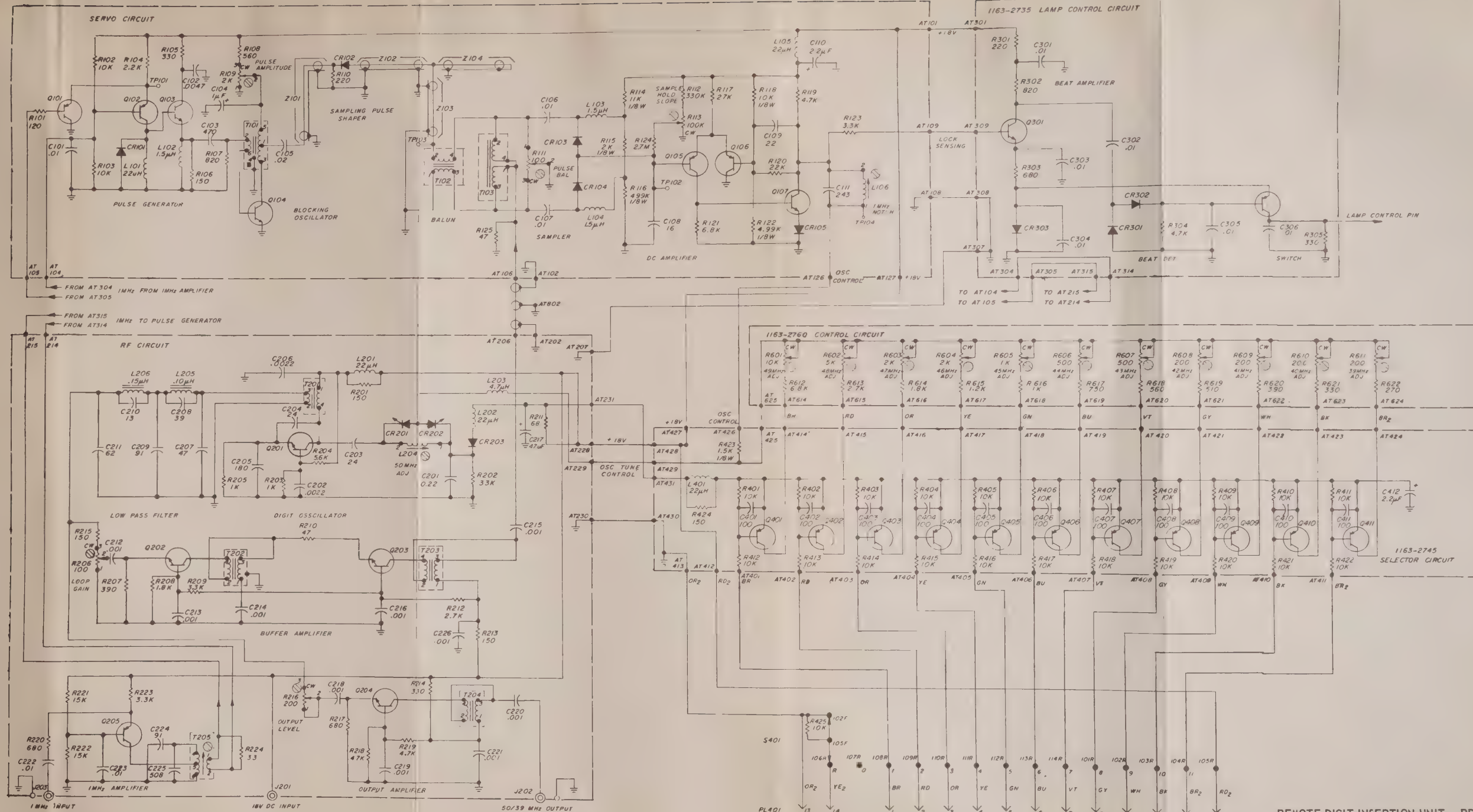
Q201, Q202, Q203



Q107, Q301

TRANSISTOR BASE DIAGRAMS (BOTTOM VIEW)

Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually, the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.



REMOTE DIGIT INSERTION UNIT - RDI-4

Figure DD-21. Over-all schematic diagram for the Remote Digit Insertion Unit RDI-4 (P/N 1163-4005).

ELECTRICAL PARTS LIST
 (Used only with schematic diagram, Figure DD-23)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C101	thru				
C111	Ceramic, 0.001 μ F $\pm 10\%$ 500 V	4405-2108	72982	801, 0.001 μ F $\pm 10\%$	5910-914-0087
C112	Ceramic, 1 μ F $\pm 20\%$ 25 V	4400-2070	80183	5C13, 1 μ F $\pm 20\%$	5910-083-6445
RESISTORS					
R101	thru				
R111	Composition, 10 $k\Omega \pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 $k\Omega \pm 5\%$	5905-683-2238
R112	thru				
R122	Composition, 2.7 $k\Omega \pm 5\%$ 1/4 W	6099-2275	75042	BTS, 2.7 $k\Omega \pm 5\%$	
R123	Composition, 47 $\Omega \pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 $\Omega \pm 5\%$	
R124	Composition, 47 $\Omega \pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 $\Omega \pm 5\%$	
R125	Composition, 100 $\Omega \pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 $\Omega \pm 5\%$	
SOCKET					
SO101	Socket, multipin, Amphenol 57-20140	4230-5004	24655	4230-5004	

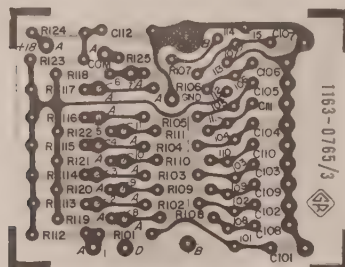


Figure DD-22. Etched-circuit board assembly for RDI-4 Filter Plug (P/N 1163-2766).

NOTE: The number appearing on the foil side is not the part number. The dot on the foil at the transistor socket indicates the collector lead.

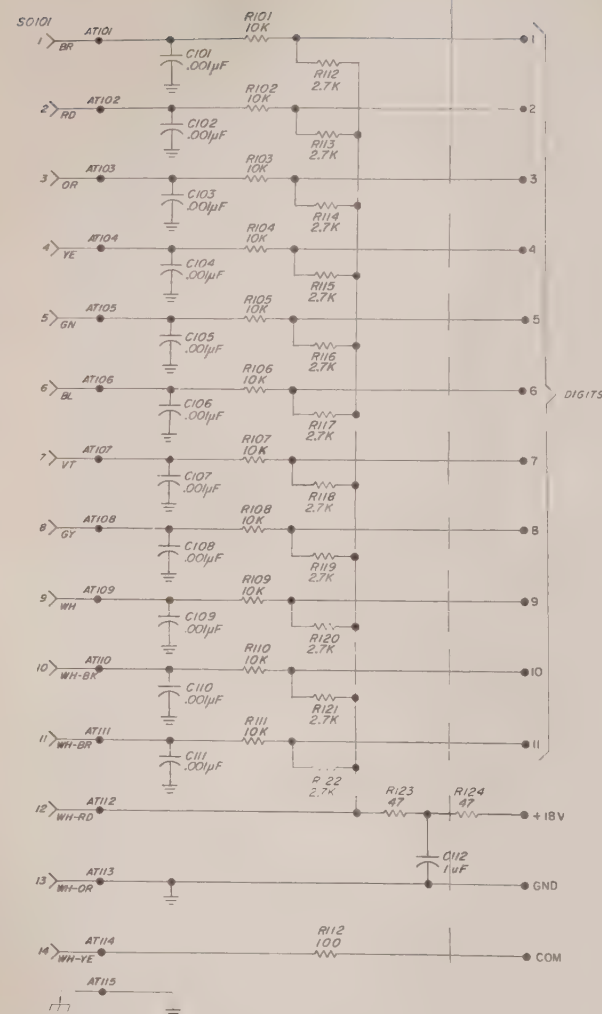


Figure DD-23. Schematic diagram for the Filter Plug FP-4 (P/N 1163-4090).

NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICO FARADS, LESS THAN ONE IN MICRO FARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. KNOB CONTROL
4. RESISTORS 1/4 WATT.	8. SCREWDRIVER CONTROL
	9. AT - ANCHOR TERMINAL
	10. TP - TEST POINT

section **DI**

**DIGIT-INSERTION UNIT, RDI-1B
FOR REMOTE/LOCAL
PROGRAMMING**

P/N 1160-4006

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SECTION DI-1

INTRODUCTION

DI-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis."

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension by experienced service personnel. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate part identification, reference designators used in the text and appearing on the photographs are the same as those used on the complete schematic diagram and in the parts list.

The service instructions rely on the use of a properly functioning synthesizer as a basic test frame for an individual module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the wide-spread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty.

DI-1.2 PURPOSE.

In General Radio synthesizers, output-frequency generation (remotely programmed, or in accordance with the setting of the front-panel dials) is accomplished by the modules occupying the top of the Main Frame chassis. Of these, the majority are identical and interchangeable and permit selection of crystal-locked frequencies in steps ranging from 0.01 c/s to 100 kc/s, depending on the model and the position of the module. The module described in this section is called the Digit Insertion Unit RDI-1B; the 'R' indicates a remote programming capability.

Solid-state circuitry that performs this operation, with the aid of certain fixed direct derivatives of the master crystal oscillator, is self-contained in the RDI-1B package, shown in Figure DI-1. The unit is a convenient plug-in module; all connections to the Main Frame are made automatically as it is installed.

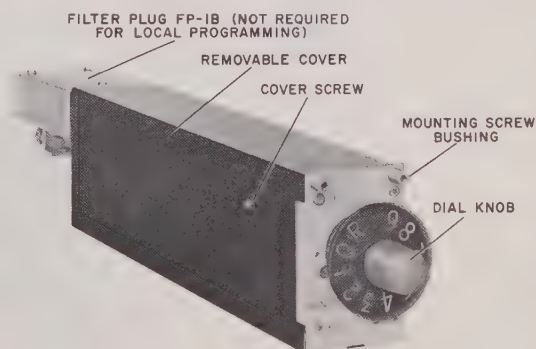


Figure DI-1.
Remote/Local Programmable Digit-Insertion Unit,
(P/N 1160-4006).

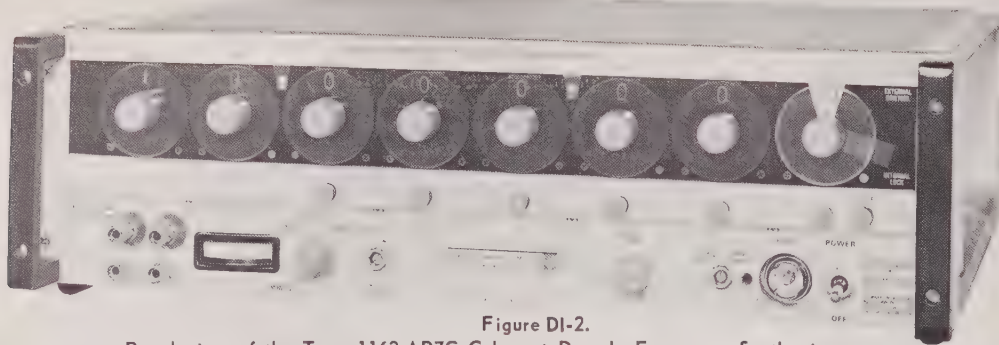


Figure DI-2.
Panel view of the Type 1162-AR7C Coherent Decade Frequency Synthesizer

The RDI-1B affords complete flexibility in the programming of GR Synthesizers. If only local frequency selection is desired, the modules are supplied without the filter plug and remote cabling. Complete or partial remote programming is added with the filter plug and cable for the appropriate modules.

In all GR Synthesizers, the RDI-1B may be used as a replacement for the DI-1 and RDI-1 modules; see paragraph 1.4.4 for Filter Plug information.

DI-1.3 DESCRIPTION.

The RDI-1B Digit-Insertion unit, with its cover installed, is shown in Figure DI-1. The only external manual control of the unit, the digit-selector switch, is operated by the 1/4-inch shaft and the dial knob visible in front. The ten numbered positions of the dial permit manual frequency selection. The eleventh position, marked "R," transfers control of the frequency setting to the leads in the control cable at the rear of the unit. Figure DI-2 shows a synthesizer with digit-selection controls set at 10MHz.

Connections for remote frequency selection are made through the Filter Plug, FP-1B, shown at the rear of the RDI-1B unit in Figure DI-1. Figure DI-3 shows the Filter Plugs connected to the rear of the programmable digit stations of a synthesizer. The Filter

Plug engages a printed-circuit connector protruding through the rear wall of the RDI-1B unit and the attaching screw threads into the support bar across the back of the synthesizer.

A small plastic lamp holder, which is part of the RDI-1B as supplied, fits in the synthesizer panel behind the control knob. This holder permits installation of the dial lamp in the instrument front panel, behind the dial, after the RDI-1B has been mounted in the Main Frame (see Figure 5-2 in the systems portion of this manual).

The entire RDI-1B assembly is held in the Main Frame by two 4-40 screws that engage the threaded bushings in the top corners of its small front panel and by a hold-down clamp that secures the reinforced bottom of the cover unit at the rear, through a small cutout.

All electrical connections to the Main Frame except one are made by banana-type plugs through the bottom of the cover into the RDI-1B assembly. The dial lamp is energized and switched in the Main Frame as explained in Section 4.6 (system portion). It can also be controlled from the RDI-1B, and this control-signal connection is made by a small pin in the RDI-1B front panel to a spring contact on the instrument front panel. This pin is part of a sensing circuit that extinguishes the lamp in case of malfunctions.

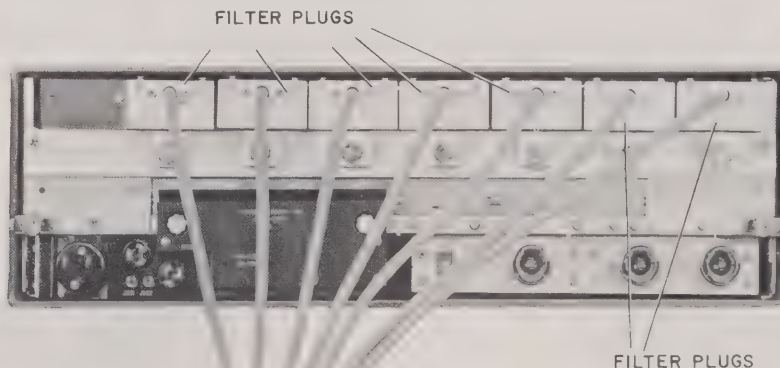


Figure DI-3.
Rear view of the synthesizer of Figure DI-2, showing plug-in filters and remote cabling.

All connections are thus established automatically when the unit is installed.

No. 4-40 screws on either side of the unit fasten the cover to the Digit-Insertion unit frame structure. After their removal, the unit can be withdrawn from the cover, if the case is held in one hand and the unit is pulled by its switch shaft with the other.

The circuitry of the RDI-1B is contained primarily on five etched-circuit boards. These boards are individually shielded and mount most components, furnishing the electrical connections between them. In the unshielded bottom board are 6 banana jacks and 2 special ground contacts, which make the electrical connections to the Main Frame mentioned earlier.

Signal flow and circuit layout are so arranged that a minimum of wiring between boards is required and each individual board assembly can be removed from the structure, after connecting-wire leads have been unsoldered and appropriate screws removed.

DI-1.4 INSTALLATION.

DI-1.4.1 GENERAL.

If the RDI-1B unit is to be added to a synthesizer to fill out an incomplete series of step digits, observe the procedures that follow to install the unit.

DI-1.4.2 PREPARATION

a. Remove the four knurled screws on the front panel of the synthesizer (accessible through cutouts in the handles), release the two cabinet clamps at the rear of the chassis, and withdraw the instrument from its cabinet.

b. Remove the two Phillips-head screws at the ends of the dial strip, along the top of the front panel, and dismount the strip.

c. Remove the screw in the lower right-hand corner of the cover plate that is installed in the unused digit station and remove the plate; replace the screw.

NOTE

Do not remove both screws in the cover plate, or the lamp-switching assembly, behind the panel, may become dislocated.

- d. Unplug the bridging unit from the digit station.
- e. Continue with paragraph DI-1.4.3.

DI-1.4.3 RDI-1B MOUNTING

To mount the RDI-1B unit in the vacant digit station proceed as follows:

a. Make sure that the Filter Plug is disconnected from the RDI-1B module, that the dial knob is removed, and that the digit-selector shaft is set with "5" marking uppermost.

b. Insert the selector shaft through the keyhole opening in the front panel of the synthesizer, place the unit over the banana plugs protruding from the chassis in the digit station, and press down gently to engage the plugs.

c. Swing the chassis clamp bar into the recess in the rear of the module and tighten the screw there.

d. Install the dial light and holder on the two prongs at the top of the keyhole cut-out.

e. Install the two Phillips-head screws beside the dial light assembly.

f. Complete installation by reversing steps a. and b. of paragraph DI-1.4.2.

DI-1.4.4 FILTER-PLUG WIRING.

For remote programming, the FP-1B Filter Plug (Part Number 1160-4091) is required.

NOTE

The FP-1B is designed specifically for use with the RDI-1B module. Do not attempt to use the FP-1 Plug interchangeably with the FP-1B Plug.

The Filter Plug, FP-1B, must be wired to the external programmer. For synthesizers purchased initially with programmable digits, a 50-foot roll of special 12-wire cable is furnished. For conversions or expansions this cable is recommended as an accessory available; the catalog number is 1160-9650 (50-foot lengths). See Figure DI-4 for a completed FP-1B assembly and Figure DI-5 for cable preparation details.

To wire a Filter Plug proceed as follows:

a. Remove the three Phillips-head screws on the top of the plug assembly, to release the cover, and pull it off the unit.

b. Release the two Phillips-head screws and remove the cable-clamp-and-ferrule assembly at the rear of the plug.

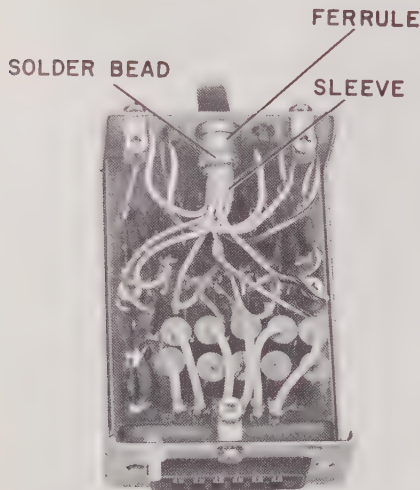


Figure DI-4.

Interior view of Filter Plug FP-1B showing remote wiring connection.

c. Remove the brass shipping clip from the clamp assembly. Carefully set aside the 3/16-inch ferrule and the 3/8-inch Teflon sleeve.

d. Insert the cable through the flanged end of the opening in the clamp, so that at least 4 inches protrudes.

e. Strip 2 1/2 inches of the grey vinyl jacket from the end of the cable, taking care not to sever the braid underneath it (see Figure DI-5).

f. Remove 2 inches of the braid, measured from the end of the cable. Take care not to unravel the Mylar sheath.

g. Expand the Teflon heat-shield sleeve just enough to allow it to pass over the Mylar sheath. Use the end of a pair of needle-nose pliers.

h. Install the Teflon heat-shield sleeve over the end of the Mylar sheath and cable, approximately 1/2 inch.

i. Pull the cable back through the clamp assembly, until the end of the jacket is 1/8-inch inside the clamp.

j. Fold the braid back over the outside surface of the clamp and trim the flared ends so that they are just short of touching the shoulder of the clamp.

k. Slip the ferrule over the end of the cable and press it over the braid, back far enough for 1/8-inch of braid to be exposed at the inside end.

l. Press the Teflon sleeve back under the clamp assembly so that no more than 1/4-inch of the sleeve is still visible.

NOTE

The ferrule should not touch the shoulder of the clamp assembly.

m. Run a solder bead completely around the inside end of the assembly to bond the ferrule to the braid and to the clamp.

n. Unravel the Mylar sheath back to the Teflon heat-shield sleeve and cut off.

o. Strip the ends of the individual leads (1/4-inch) and tin the exposed wires. Cut 1/8-inch off the ends of the tinned leads. Reinstall the completed clamp assembly in the plug.

p. Press individual leads into selected lugs and solder each one at the time of insertion. (Refer to paragraph DI-1.4.5 for sequence and lug-selection details.)

q. Dress the leads as shown in Figure DI-4. The planned slack in the leads provides service loops that permit easy alteration of the wiring at a later time, if desired.

DI-1.4.5 WIRING-CODE SELECTION.

It is recommended that the leads of the special 12-conductor cable be soldered to the lugs on the etched-circuit board of the FP-1B Filter Plug unit in order shown in Table DI-1. Note that, for the digits 0 through 8, the single color trace on the white jacket of each lead corresponds to the standard EIA color

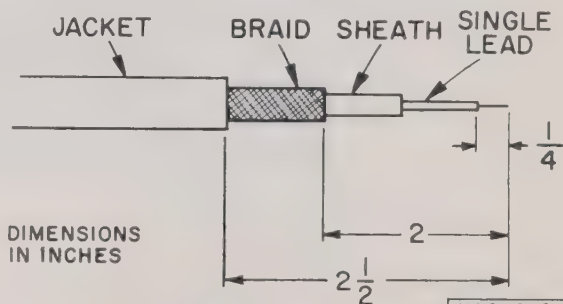


Figure DI-5.

Remote-programming control cable preparation details.

code, which should make it easier to keep the program code in sequence at the other end of the cable.

The white-with-blue-black-trace lead should be soldered to the lug marked COM, to complete the digit-selection wiring.

The two remaining leads should be soldered to lugs as indicated in the table.

TABLE DI-1
CONTROL-CABLE CONNECTION
(See Figures DI-4 and DI-19)

Lug Marking	Lead Identification
0	White with black trace
1	White with brown trace
2	White with red trace
3	White with orange trace
4	White with yellow trace
5	White with green trace
6	White with blue trace
7	White with violet trace
8	White with grey trace
COM	White with blue/black trace
+18	White with blue/brown trace
GND	White with black/brown trace

DI-1.4.6 FINAL INSTALLATION.

To complete the installation of a programmable-digit station, proceed as follows:

a. Reinstall the cover and plug the FP-1B on the printed-circuit connector protruding through the rear of the RDI-1B unit.

b. Thread the clamp screw on the bottom of the plug into the tapped hole in the support bar at the rear of the synthesizer and finger tighten.

c. Select an adequate length for the cable to reach the programmer and cut the cable. Attach it to the programmer, observing the color-code selections indicated in paragraph 1.5.

NOTE

The 4-inch length of aluminum channel stock supplied with the plug is a clamp-screw extender that is required only when the plug is to be used on a Type 1164 Synthesizer.

To allow for greater chassis depth of the Type 1164 Synthesizer, the extender rod should be installed in place of the swivel-mounted clamp screw on the bottom of the Filter Plug. The cutaway end attaches to the plug. Then, if the nut is remounted on the bottom of the rod at the other end, the Filter Plug can be affixed to the support bar across the rear of the synthesizer.

DI-1.5 OPERATION.

DI-1.5.1 GENERAL.

The selection of an RDI-1B digit frequency, from a remote location connected to the synthesizer by wires, is accomplished by establishing connections between these wires. As long as the dial of the RDI-1B unit is set to one of the digits 0-9, the digit frequency corresponding to this local selection is generated regardless of any existing remote-wire connection. In the "R" dial position, control of frequency is transferred to the output terminals of the FP-1B unit, from which point it may be extended as desired.

For programmed operation, the unit is controlled by a 10-line code. Digit selection can be accomplished by closure between wires by contact, by transistor switch, or other suitable means. Switching power is internally supplied. The time interval occurring between contact closure and the presence of a newly selected frequency is 200 μ s, maximum. On long cable runs, the resistance of any lead should not exceed 100 Ω .

DI-1.5.2 TEN-LINE OPERATION.

In the ten-line mode each digit selection is made by one closure only, consequently 10 wires (one COMMON and 9 digit leads) are required. The code is listed Table DI-2 - all closures are to the common lead.

TABLE DI-2
TEN-LINE CONNECTION CODE FOR
FP-1B FILTER PLUG
(See Figures DI-18 and DI-19)

Digit	Solder Terminal								
	0	1	2	3	4	5	6	7	8
9									none
8								x	x
7							x		
6						x			
5					x				
4				x					
3			x						
2		x							
1									
0	x								

x = Connect terminal to COM to actuate digit.

DI-1.5.3 ELECTRONIC KEYING.

Where mechanical contacts are not desired, circuits may be closed by transistors or any other suitable electronic device. Saturated operation is suggested, but a drop of up to 1.3 V can be tolerated. Current through the switch is 6.5 to 7.5 mA.

SECTION DI-2

PRINCIPLES OF OPERATION

DI-2.1 GENERAL.

The main circuits of the RDI-1B are shown in the block diagram, Figure DI-6 (see also the full schematic diagram, Figure DI-17).

In accordance with the flow in the synthesizer itself, where the signal is fed from DI-1B to DI-1B (from right to left), the main signal flow in the block diagram is from right to left, along the horizontal axis of the figure.

Ancillary signals, which are used in common by all RDI's, consist of the 42-Mc signal to the Input Mixer and the Picket-Fence input to the Digit Phase Detector. These signals are supplied by the AFS unit (Section CA), from common busses in the Main Frame chassis (Sections BA, BB and BC).

Operating frequencies, or frequency bands, are indicated inside the blocks of the diagram. Above the blocks, frequencies that would result from an arbitrary input frequency of 5.069 Mc/s and a digit selection of 5 are indicated as an example.

A simple numerical example will serve to explain this operation:

Since (from paragraph 4.4)

$$f_{out} = f_c + \frac{f_{sin}}{10} + 10d \quad \text{kc/s}$$

and if

$$f_{sin} = f_{in} - f_c$$

so that

$$f_{out} = f_c + \frac{f_{in} - f_c}{10} + 10d,$$

with

$$f_{in} = 5069 \quad \text{kc/s}$$

and

$$d = 5 \text{ (digit setting),}$$

then

$$f_c = 5000.0 \quad \text{kc/s}$$

$$\frac{f_{in} - f_c}{10} = 6.9 \quad \text{kc/s}$$

$$10d = 50.0 \quad \text{kc/s}$$

with the result that

$$f_{out} = 5056.9 \quad \text{kc/s}$$

From the comparison of f_{in} and f_{out} , it is obvious that in f_{out} a "5" has been *inserted* between the 0 and 6 of the input frequency.

DI-2.2 SIGNAL FLOW.

The input signal, 5.069 Mc/s in the example, reaches the Input Mixer through a fixed-tuned transformer. The amplified 42-Mc signal from the AFS is added here and the upper sideband is selectively amplified in the following buffer. This signal of 47.069 Mc/s is fed into the Digit Mixer, where a 100-kc multiple between 3.0 and 3.9 Mc/s is added. This "digit" signal comes from the Digit Oscillator, which is phase-locked to a particular component in the Picket Fence, as described below.

The number following the decimal point in the Digit-Oscillator frequency (in Mc/s) is the same as the number to which the digit-selector dial has been set, so that 3.0 Mc/s corresponds to "0", 3.1 Mc/s to "1", and so on. If, as in this example, the dial has been set to digit "5", then 3.5 Mc/s is added to 47.069. The resulting upper sideband of this mix is 50.569. This signal is filtered, amplified, and fed into the Divider Phase Detector.

The remainder of the main signal circuit produces a division by 10 and as a result the Output Oscil-

Simplified block diagram for Remote/Local Programming Digit-Insertion Unit.

The Phase-Detector output controls the oscillator frequency by means of a varactor diode. This phase-lock loop locks the Digit Oscillator to a frequency controlled by the primary crystal oscillator in the AFS. The Digit Oscillator is tuned approximately to one of the ten frequencies by diodes that

The output amplifier, however, also serves as a switch which cuts off the output in case of certain malfunctions. No injection into the Divider Oscillator causes it to free-run, producing an incorrect frequency. A dc voltage from the mixer is used to safeguard against this condition. In the absence of the dc voltage, the electronic switch will open, thereby extinguishing the dial light and cutting off the output. Another input to the switch monitors the digit-phase lock, so that no output is produced if a beat signal is present in that loop.

DI-2.3.1 GENERAL.

Circuits, and the location of prominent components, are discussed in the sequence in which the signal passes through the Digit-Insertion Unit. Reference will be made to the block diagram, Figure DI-6, and the over-all schematic diagram, Figure DI-17. Figure DI-7 is a useful reference for physical identification of the circuits discussed.



DI-2.3.2 INPUT SECTION.

The input section consists of an Input Mixer preceded by a 42-Mc/s Buffer and followed by a 47-47.1 Mc/s Buffer. The 42-Mc/s Buffer is a common-emitter stage, Q102, with a tuned output coil, L101, that serves as an isolator, amplifier and impedance transformer for the 42-Mc/s signal from the AFS. This signal is taken from the 42-Mc/s bus, through J706, and processed for injection at the Input Mixer. The input network of the buffer is of moderately high impedance.

The Input Mixer combines the incoming 5.0-5.1-Mc/s signal from J705 and the 42-Mc/s signal from the buffer. The 5.0-5.1-Mc/s input, of approximately 0.30-V, is stepped up in T101 and applied to Q101. The connection between L101 and T101 feeds the 42-Mc/s signal to the transistor and also completes the bias circuit. The circuit L102/C106, tuned to the upper sideband (47-47.1 Mc/s), effectively eliminates the 42-Mc/s component in the output and provides substantial rejection for the ninth-harmonic component of the 5-5.1-Mc/s input signal.

Q103 is a buffer-amplifier which amplifies the 47-47.1-Mc/s signal for application to the Digit Mixer. Tuned output coil L104 further contributes to the selectivity for the suppression of unwanted mixer output components.

The input circuits are located in the bottom right-hand side shield-compartment (when looking at the front face of the module).

DI-2.3.3 DIGIT MIXER AND DIVIDER.

A coaxial connection brings the 47-47.1-Mc/s signal from the Q103 buffer stage to C503 and C509, which form the input to the Digit Mixer, located in the Digit-Oscillator compartment. The second signal into this mixer is the Digit-Oscillator output of 3.0-3.9 Mc/s, in 100-kc/s steps. The resultant output is 50-51 Mc/s ($47 + 3.0$ to $47.1 + 3.9$ Mc/s). To obtain an equalized output over the 1-Mc/s bandwidth, a double-

tuned filter, T301/L301, couples the signal into the Divider Oscillator.

The Digit Mixer and Buffer circuits are located in the top left-hand shielded compartment. This compartment also houses the Divider Oscillator and the Output Amplifier. L302 effectively grounds the base of Q303, the oscillator transistor, at the oscillation frequency, while C310 resonates this coil for the 50-51 Mc/s signal, forming a very low-Q tank. The oscillator is a Colpitts type with C312, C313, and C314 forming the feedback voltage divider. The Output Amplifier, common-emitter stage Q304, is connected to the oscillator emitter where output level adjustment is provided by R306.

The Q304 Bias network is completed through a switch, Q502 and Q503, which is located on the Digit Oscillator board but covered here for functional reasons. This switch can cut off the 5.0-5.1 Mc/s output signal. Forward bias for Q304 is only supplied if Q503 and Q502 are turned on by a +0.6 V dc signal coming from the Digit Mixer, Q301 and Q302. This voltage indicates proper input signal levels to the Digit Mixer. The +0.6 V dc signal can be negated by a dc output from the lock monitor (covered later).

For normal operation (Q304 turned on), tuned transformer T302 couples the output signal to J704, the output jack.

Note that the contact associated with J704, as the contact near the input J705, is not internally grounded. Ground springs on the Main Frame connect both the output and input ground contacts of adjacent RDI-1B units. The fact that the springs are connected to the chassis in only one place increases the isolation of the input and output circuits, since the chassis has to carry no current.

DI-2.3.4 DIGIT OSC., SELECTOR AND PHASE LOCK.

The Digit Oscillator provides injection frequencies to the Digit Mixer, which are the crystal-locked 100-kc steps between 3.0 and 3.9 Mc/s. While all of

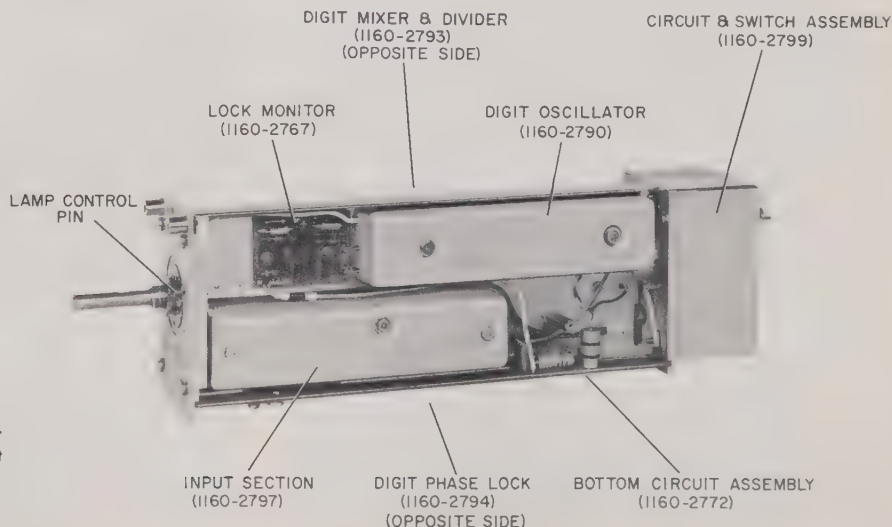


Figure DI-7.

RDI-1B module with cover off. Referenced figures give circuit-layout details.

these frequencies are present simultaneously in the Picket Fence (generated in the AFS), only one specific frequency is required for each setting of the digit-selector. All others must be kept out of the Digit Mixer, in order to avoid spurious outputs. The selection and filtering of the proper Picket-Fence frequency is achieved by a step-tuned oscillator and a phase-lock loop.

Colpitts-oscillator Q501 is tuned to each of the ten frequencies by diode-selected trimmer capacitors, C401 through C415. C505 is always connected and is used alone to adjust the 3.9-Mc top frequency initially (digit-selector setting 9). Digits 8, 7, 6, 5, 4, 3, 2, 1, 0 are set by C401, 402, 403, 405, 407, 409, 411, 413, 415, in that order. The circuit inductance, T501, is preadjusted to the proper value. In the Oscillator, part of the capacitance of the tuned circuit is represented by voltage-variable capacitance (CR501), to obtain phase-lock capability.

Diodes CR401-409 are all connected to a positive (+8-V dc) supply on one side; completion of the circuit to ground from the other end (CR410-418) will select a particular digit. Diodes in the circuits not selected remain backbiased. S401 closes these circuits in positions 0-9. In the "R" position the remote common lead is grounded, so that digits may be selected by connection of a digit wire to the common lead externally.

To avoid signal radiation and cross-coupling, remote wires are passed through Filter Plug FP-1B before leaving the instrument.

Two video-amplifier stages, Q601 and Q602, amplify the oscillator signal for injection into the Digit Phase Detector. The reference side of the phase detector is transformer-connected (T601) to the balanced

Picket-Fence bus in the Main Frame. The phase detector control-signal output is filtered and applied to the varactor diode, CR501. If the Digit-Oscillator free-running frequency deviates from the chosen crystal-derived Picket-Fence frequency, the phase of this oscillator signal shifts, until the phase detector produces enough dc output to correct the oscillator frequency by means of the varactor diode.

Picket frequencies to which the oscillator is not locked produce 100-kc, 200-kc, etc, outputs from the phase detector that would frequency modulate the oscillator if not suppressed. Consequently, sufficient attenuation of these signals and retention of adequate capture range are important requirements. The filter, in the control line between the phase-detector output and the oscillator varactor diodes, therefore, passes low frequencies but has zeros at 100 and 200 kc.

The circuits described are housed in the following shielded compartments: Digit Selector: rear compartment. Digit Oscillator: top right-hand side. Digit Phase Lock: bottom left-hand side.

DI-2.3.5 LOCK MONITOR

Capture of the digit phase-lock loop is monitored by a lock-sensing circuit. The input amplifier, Q201, is connected to the control line to amplify ac signals present. Any two signals that enter the phase detector without achievement of lock will produce an ac output that corresponds to their frequency difference. This output is applied to the voltage-doubler-rectifier, CR201 and CR202, and is used to cut off transistor Q503, which in turn will cut off the output signal. This will also (through the lamp-control pin) extinguish the dial lamp on the front panel, to give warning of malfunction.



SECTION DI-3

SERVICE AND MAINTENANCE

DI-3.1 INTRODUCTION.

Most malfunctions in the RDI-1B will be indicated by an extinguished dial light, provided the CAD unit is not inserted in the particular position and a concurrent absence of the normal (approximately 0.3-V) output. No output, however, will cause the next RDI to the left to extinguish its dial light and produce no output, and so on. The RDI-1B at fault, therefore, is the right-most unit with no dial illumination.

Self-check procedures of Section 5 (in the front of the manual) permit isolation of a faulty unit in cases where dial light indication is normal. If service is required, remove the unit from the chassis (paragraph 5.4.2) and replace it with a bridging unit (paragraph 5.5.1).

It is recommended that the unit be returned for service to the General Radio Company (particularly within warranty). Where this is not possible, certain tests can be made in the field, but a thorough understanding of the principles of operation is essential (refer to Section DI-2 above).

The procedures that follow will permit isolation of the fault, so that corrective measures can be taken. The preferred servicing method after location of the fault is the replacement of the circuit board in question. The shields do not, in general, permit retuning of circuits and replacement of individual components in the field, and is therefore limited to items not affecting tuned circuits. Since the synthesizer Main Frame can be used as a test fixture, refer to the appropriate Main Frame chassis schematic (Section BA, BB or BC) as well as to the over-all schematic for the unit, Figure DI-17.

NOTE

Reference is made to banana plugs and other test points on the Main Frame by the designations used in Chassis 1160-4060.

DI-3.2 TEST EQUIPMENT.

Table DI-3 lists recommended test equipment required to test the RDI-1B module. Equivalent equipments may be substituted.

DI-3.3 TROUBLE ANALYSIS.

DI-3.3.1 GENERAL.

CAUTION

Turn power off during set-up changes
to avoid accidental short circuits.

Remove the malfunctioning RDI-1B unit from the Main Frame and withdraw the unit from its cover, after removal of the 4-40 screws on each side. Reinstall the unit (complete with dial lamp) carefully in station VII, next to the CAD unit. Do not install Filter Plug FP-1B. Remove the CAD unit, as in paragraph 5.4.3 (front part), as well as the DI unit in station VI. Do not install a bridging unit in this space. The Calibrating Mixer module does not have to be removed.

Use Figures DI-8 and DI-9 to locate interior test points.

DI-3.3.2 POWER INPUT.

With the VTVM look for $+18 \pm 0.2$ V dc at AT706 on the bottom circuit board. If the indication is abnormal,

TABLE DI-3
TEST EQUIPMENT

<i>Function</i>	<i>Type Recommended</i>	<i>Minimal Characteristics</i>
Electronic Voltmeter (VTVM)	GR 1806 (with 1806-P1 probe)	BW 1-55 Mc/s; sensitivity 0.2 V; probe capacity 2.0 pF maximum
Digital Frequency Meter	GR 1191-Z	Dc to 50 Mc/s; resolution 100 c/s; sensitivity 0.1 V; input impedance > 500 ohms
Oscilloscope	Tektronix 543 (with C/A plug-in and P6006 10× probe)	20 Mc/s, 0.5 V/cm, 8 pF (or less) probe.

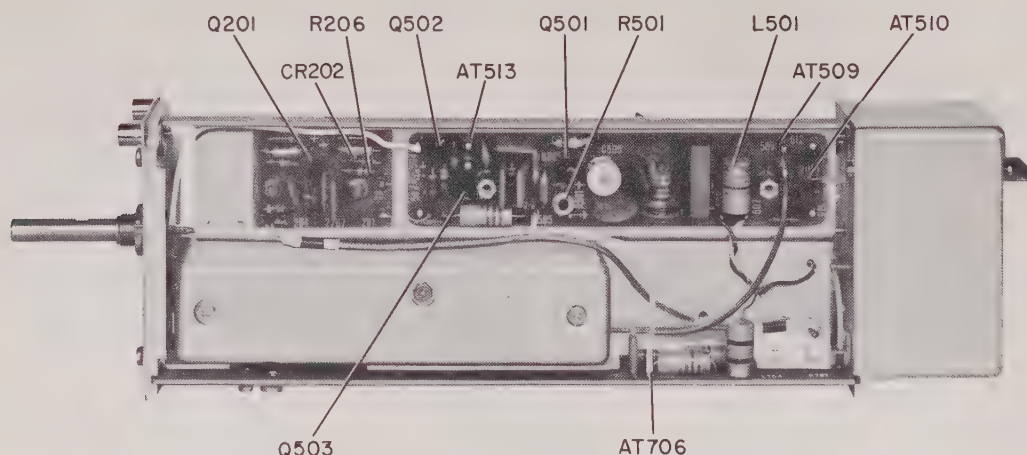


Figure DI-8. RDI-1B interior test points and adjustments. Top left oblique view.

mal, check the distribution of this supply voltage in the Main Frame chassis and this output of the Power Supply module. If the indication is normal, continue with the procedures below.

DI-3.3.3 OUTPUT CONDITION.

Connect the oscilloscope or the VTVM between PL212-6 and the ground spring on the top deck of the Main Frame, to the left of the RDI-1B under test. Depress the CAD OFF button and turn the POWER switch on. An rf voltage of 0.2 to 0.4-Vrms should be present, in which case proceed to paragraph DI-3.3.4. If no indication is obtained, or if inadequate voltage is observed, move the scope or VTVM to AT705. If the signal is present here, the CAD switch in the chassis is faulty and must be cleaned or repaired first. Then proceed to paragraph DI-3.3.4, or, if no indication is obtained at AT705, continue with paragraph DI-3.3.5.

DI-3.3.4 OUTPUT SIGNAL PRESENT.

If output is present, connect a counter to PL212-6 (connects with J704 on RDI-1B) and observe the output

frequency corresponding to the dial settings of the unit. A properly functioning unit would indicate 5.0100 Mc/s for digit 1, 5.0200 Mc/s for digit 2, and so on. If these indications are obtained through all digits it can be assumed that the proper input (0.3-V rms) was not present when the unit malfunctioned, or that the fault is in the FP-1B, the remote wiring on control, if the unit was remotely programmed.

If the output frequency is outside the 5.0-5.1 Mc/s band, the Digit Mixer and Divider-board is at fault. It is possible to check and set the divider oscillator frequency in the following manner: Remove the shield from the Digit Oscillator section (top right hand) and carefully connect a 22-k Ω resistor between AT513 and ground. (This disables the electronic switch, so that the output signal is kept on in the absence of input.) Remove the input by depressing the CAD button under the empty CAD position. Read frequency. If not $5,050 \pm 10$ kc/s, reset with trimmer C313. To do this, the shield of the Digit Mixer and Divider section will have to be removed; 5,050 kc/s to be obtained after the shield is reinstalled.

Remove the 22-k Ω resistor, and remount the Digit Oscillator shield. If the output frequency in response to dial operation moves in steps of nearly (but

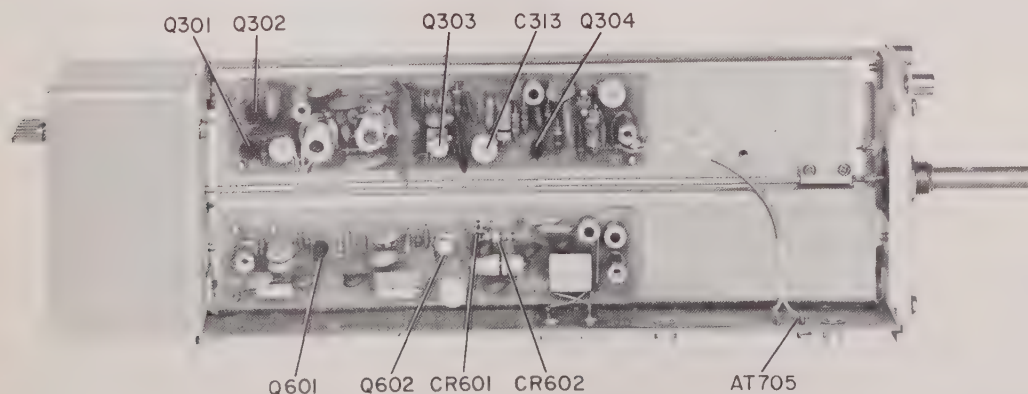


Figure DI-9. RDI-1B interior test points and adjustments.



not exactly) 10 kc/s, the digit oscillator is not locked due to the absence of one signal into the Phase Detector. If the picket-fence frequencies are present (Section 5, front part of manual), the Digit Phase Lock board is at fault. Remove the shield can and check for a signal of 4-9 V at the junction of CR601 and CR602. Proceed with dc-voltage checks from there.

DI-3.3.5 NO OUTPUT SIGNAL.

The absence of the output signal would generally indicate that the electronic switch was cut off in response to one of three abnormal conditions:

1. 47-Mc/s signal from input section low or absent.
2. Digit-Oscillator signal low or absent.
3. Digit Oscillator unlocked.

The 47-Mc/s signal level may be measured with the VTVM at AT509 after removal of the Digit-Oscillator cover. If the reading is not 0.9 to 1.2 V, the input section is not operating properly.

The Digit-Oscillator level at AT510 is 1.6-1.8 V (remove the Digit-Oscillator cover for this measurement). Minor adjustments with R501 are justified, but

a large discrepancy points to some other defect in the oscillator.

If the Digit Oscillator is unlocked, a negative voltage will be developed in the lock monitor at the junction of CR202 and R206. The free-running Digit-Oscillator frequency may be measured at AT802 (use short cable on counter) after the Picket-Fence Generator in the AFS has been disabled. To do this, remove the link between terminals 5 and 6 of L501 in the power-supply module (component side of etched-circuit board on top of the coil; refer to Section G).

Nominal frequencies are 3,000, 3,100, 3,200 . . . 3,900 kc/s ± 5 kc/s. If only one frequency is off, the trouble is in the selector; if all frequencies are shifted, the Digit Oscillator is at fault.

DI-3.4 DC VOLTAGES.

After isolation of a faulty circuit section, dc voltages may be useful in further tracing of troubles. Table DI-4 presents dc-voltage readings.

TABLE DI-4

TYPICAL DC VOLTAGES

<u>Transistor</u>	<u>Emitter</u>	<u>Base</u>	<u>Collector</u>
Q101	13.0	13.0	0
Q102	1.1	1.8	13.0
Q103	0.85	1.6	12.5
Q201	6.4	7.0	14.0
Q301	0.65	0	18.0
Q302	0.65	0	18.0
Q303	3.8	3.5	17.5
Q304	17.5	16.5	0
Q501	1.2	1.8	16.5
Q502	10.3	9.5	10.0
Q503	GND	0.65	0.32
Q601	10.5	9.6	5.4
Q602	17.5	16.8	0

NOTES:

Unit operating with all inputs installed in chassis, no cover.
 Voltages measured with Type 1806-A direct.
 These are typical readings and they are somewhat dependent on rf signal levels.
 Variations of $\pm 15\%$ are to be expected.

PARTS LIST
RDI-1B

REF. NO.	DESCRIPTION	PART NO.	FED. MFG CODE	MFG. PART NO.	FED. STK. NO.
CAPACITORS					
C101	Mica, 162 pF $\pm 1\%$ 500 V	4640-2160	72136	CM15, 162 pF	
C102	Ceramic, 0.0047 μ F $\pm 80-20\%$ 500 V	4405-2470	72982	801, 0.0047 μ F $\pm 80-20\%$	
C103	Mica, 110 pF $\pm 5\%$ 500 V	4640-0510	72136	CM15, 110 pF $\pm 5\%$	
C104	Ceramic, 0.01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C105	Ceramic, 0.001 μ F $\pm 10\%$ 500 V	4405-2108	72982	801, 0.001 μ F $\pm 10\%$	5910-914-0087
C106	Mica, 62 pF $\pm 5\%$ 500 V	4640-0394	72136	605, 62 pF $\pm 5\%$	
C107	Ceramic, 68 pF $\pm 10\%$ 500 V	4400-0068	78488	GA, .68 pF $\pm 10\%$	
C108	Mica, 62 pF $\pm 5\%$ 500 V	4640-0394	72136	605, 62 pF $\pm 5\%$	
C109	Ceramic, 4.7 pF $\pm 10\%$ 500 V	4400-0470	78488	GA, 4.7 pF $\pm 10\%$	
C110	Mica, 62 pF $\pm 5\%$ 500 V	4640-0394	72136	605, 62 pF $\pm 5\%$	
C111	Ceramic, 0.001 μ F $\pm 10\%$ 500 V	4405-2108	72982	801, 0.001 μ F $\pm 10\%$	5910-914-0087
C112	Ceramic, 0.001 μ F $\pm 10\%$ 500 V	4405-2108	72982	801, 0.001 μ F $\pm 10\%$	5910-914-0087
C113	Ceramic, 0.01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C201	Ceramic, 0.01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C202	Tantalum, 1.0 μ F $\pm 10\%$ 15 V	4450-4301	56289	150D105X9035A2	
C203	Tantalum, 3.3 pF $\pm 10\%$ 15 V	4450-4601	56289	150D, 3.3 μ F $\pm 10\%$	
C204	Ceramic, 1 μ F $\pm 20\%$ 25 V	4400-2070	80183	5C13, 1 μ F $\pm 20\%$	5910-083-6445
C301	Ceramic, 0.01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C302	Ceramic, 47 pF N030 $\pm 5\%$ 200 V	4400-6250	72982	855-000-BIG-470J	
C303	Trimmer, 3.5-13 pF 160 V	4910-2071	Trush Co.	TS-TRIK 0-02	
C304	Ceramic, .01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C305	Ceramic, .01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C306	Ceramic, 0.68 pF $\pm 15\%$	4400-0068	78488	GA, 0.68 pF, $\pm 15\%$	
C307	Ceramic, 51 pF N030 $\pm 5\%$ 200 V	4400-6251	72982	855-000-BIG-510J	
C308	Ceramic, .02 μ F $\pm 80-20\%$ 50 V	4402-3200	01121	35-203W, .02 μ F $\pm 80-20\%$	5910-952-8659
C309	Ceramic, 3.3 pF N30 $\pm 5\%$ 500 V	4411-9335	72982	831-000-BIG-339J	
C310	Ceramic, 330 pF $\pm 5\%$ 500 V	4404-1335	72982	831, 330 pF $\pm 5\%$	
C311	Ceramic, .01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C312	Ceramic, 62 pF N030 $\pm 5\%$ 200 V	4400-6252	72982	855-000-BIG-620J	
C313	Trimmer, 4.5-20 pF 160 V	4910-2070	Trush Co.	TS-TRIK0-02	
C314	Ceramic, 150 pF $\pm 5\%$ 100 V	4400-6300	72982	8131-025-P2G-151J	
C315	Ceramic, 22 pF $\pm 10\%$ 500 V	4404-0228	72982	831, 22 pF $\pm 10\%$	
C316	Ceramic, .01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C317	Trimmer, 4.5-20 pF 160 V	4910-2070	Trush Co.	TS-TRIK0-02	
C318	Ceramic, 137 pF N080 $\pm 1\%$ 100 V	4400-6301	72982	8131-025-U1G-1370F	
C319	Ceramic, .02 μ F $\pm 80-20\%$ 50 V	4402-3200	01121	35-203W	5910-952-8659
C401	Trimmer, 5.5-18 pF NP 0 350 V	4910-2031	72982	538-006, 5.5-18 pF NPO	
C402	Trimmer, 5.5-18 pF NP 0 350 V	4910-2031	72982	538-006, 5.5-18 pF NPO	
C403	Trimmer, 5.5-18 pF NP 0 350 V	4910-2031	72982	538-006, 5.5-18 pF NPO	
C404	Ceramic, 15 pF NPO $\pm 5\%$ 200 V	4400-6200	72982	835-000-COGO-150J	
C405	Trimmer, 5.5-18 pF NPO 350 V	4910-2031	72982	538-006, 5.5-18 pF NPO	
C406	Ceramic, 27 pF NPO $\pm 5\%$ 200 V	4400-6201	72982	805-000-GOGO-270J	
C407	Trimmer, 5.5-18 pF 350 V	4910-2031	72982	538-006, 5.5-18 pF NPO	
C408	Ceramic, 39 pF NPO $\pm 5\%$ 200 V	4400-6202	72982	855-000-COGO-390J	
C409	Trimmer, 5.5-18 pF NPO 350 V	4910-2031	72982	538-006, 5.5-18 pF NPO	
C410	Ceramic, 51 pF N030 $\pm 5\%$ 200 V	4400-6251	72982	855-000-BIG-510J	
C411	Trimmer, 7-25 pF N300 350 V	4910-2032	72982	538-006, 7-25 pF N300	5910-998-1621
C412	Ceramic, 62 pF NPO $\pm 5\%$ 500 V	4410-0625	72982	811-000-COGO-620J	
C413	Trimmer, 7-25 pF N300 350 V	4910-2032	72982	538-006, 7-25 pF N300	5910-998-1621
C414	Ceramic, 75 pF NPO $\pm 5\%$ 500 V	4410-0755	80131	CC63, 75 pF NPO	5910-964-2480
C415	Trimmer, 7-25 pF N300 350 V	4910-2032	72982	538-006, 7-25 pF N300	5910-998-1621
C416	Ceramic, 86.6 pF NPO $\pm 2\%$ 200 V	4400-6203	72982	815-000-COGO-8669G	
C426	Electrolytic, 3.3 μ F $\pm 10\%$ 15 V	4450-4601	01295	15335C2	
C501	Mica, .0047 μ F $\pm 1\%$ 500 V	4600-1400	72136	DM-20 (4CR)	
C502	Ceramic, .02 μ F $\pm 80-20\%$ 50 V	4402-3200	01121	35-203W	5910-952-8659
C503	Ceramic, 22 pF $\pm 10\%$ 500 V	4404-0228	72982	831, 22 pF $\pm 10\%$	
C504	Ceramic, 43 pF N750 $\pm 5\%$ 500 V	4417-0435	72982	0801000U2J00439J	
C505	Trimmer, 7-25 pF N300 350 V	4910-2043	72982	538-002, 7-25 pF N300	
C506	Ceramic, 91 pF N750 $\pm 5\%$ 200 V	4400-6253	72982	805-000-U2G-910J	
C507	Ceramic, 0.1 μ F $\pm 20\%$ 25 V	4400-2050	80183	5C13, 0.1 μ F $\pm 20\%$	5910-974-5695
C508	Ceramic, 0.47 μ F $\pm 20\%$ 25 V	4400-2054	80183	5C13, 0.47 μ F $\pm 20\%$	5910-974-5696
C509	Ceramic, 22 pF $\pm 10\%$ 500 V	4404-0228	72982	831, 22 pF $\pm 10\%$	
C510	Ceramic, 0.22 μ F $\pm 20\%$ 25 V	4400-2052	80183	5C13, .22 μ F $\pm 20\%$	5910-974-5694
C511	Ceramic, .01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C601	Ceramic, .01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C602	Ceramic, 220 pF $\pm 5\%$ 500 V	4404-1225	72982	831, 220 pF $\pm 5\%$	
C603	Ceramic, 270 pF $\pm 5\%$ 500 V	4404-1275	72982	831, 270 pF $\pm 5\%$	
C604	Mica, 100 pF $\pm 2\%$ 500 V	4700-0681	14655	22A, 100 pF $\pm 2\%$	

PARTS LIST (Cont)

REF. NO.	DESCRIPTION	PART NO.	FED. MFG. CODE	MFG. PART NO.	FED. STK NO.
C605	Trimmer, 4.5-20 pF 160 V	4910-2070	Trush Co.	TS-TRIKO-02	
C606	Ceramic, 220 pF $\pm 5\%$ 500 V	4404-1225	72982	831, 220 pF $\pm 5\%$	
C608	Ceramic, 100 pF $\pm 5\%$ 500 V	4404-1105	72982	831, 100 pF $\pm 5\%$	
C609	Ceramic, 100 pF $\pm 5\%$ 500 V	4404-1105	72982	831, 100 pF $\pm 5\%$	
C610	Ceramic, 51 pF $\pm 5\%$ 500 V	4404-0515	72982	831, 51 pF $\pm 5\%$	
C611	Ceramic, .01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C612	Ceramic, .01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C613	Ceramic, .01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C614	Ceramic, .01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C701	Ceramic, 0.22 μ F $\pm 20\%$ 25 V	4400-2052	80183	5C13, 0.22 μ F $\pm 20\%$	5910-974-5694

RESISTORS

R101	Composition, 220 Ω $\pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm 5\%$	5905-683-2240
R102	Composition, 1.2 k Ω $\pm 5\%$ 1/4 W	6099-2125	75042	BTS, 1.2 k Ω $\pm 5\%$	
R103	Composition, 620 Ω $\pm 5\%$ 1/4 W	6099-1625	75042	BTS, 620 Ω $\pm 5\%$	5905-801-6998
R104	Composition, 470 Ω $\pm 5\%$ 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm 5\%$	5905-683-2242
R105	Composition, 3.3 k Ω $\pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm 5\%$	5905-681-9969
R106	Composition, 150 Ω $\pm 5\%$ 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm 5\%$	5905-683-2243
R107	Composition, 18 k Ω $\pm 5\%$ 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm 5\%$	5905-687-0000
R108	Composition, 8.2 k Ω $\pm 5\%$ 1/4 W	6099-2825	75042	BTS, 8.2 k Ω $\pm 5\%$	
R109	Composition, 68 k Ω $\pm 5\%$ 1/4 W	6099-3685	75042	BTS, 68 k Ω $\pm 5\%$	5905-681-8853
R110	Composition, 100 Ω $\pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm 5\%$	
R111	Pot., Comp., 200 Ω $\pm 5\%$	6049-0104	98474	597020	
R112	Composition, 1.2 k Ω $\pm 5\%$ 1/4 W	6099-2125	75042	BTS, 1.2 k Ω $\pm 5\%$	
R113	Composition, 47 Ω $\pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm 5\%$	
R201	Composition, 47 k Ω $\pm 5\%$ 1/4 W	6099-3475	75042	BTS, 47 k Ω $\pm 5\%$	5905-683-2246
R202	Composition, 15 k Ω $\pm 5\%$ 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm 5\%$	5905-681-8818
R203	Composition, 10 k Ω $\pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm 5\%$	5905-683-2238
R204	Composition, 2.2 k Ω $\pm 5\%$ 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm 5\%$	5905-723-5251
R205	Composition, 1.5 k Ω $\pm 5\%$ 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm 5\%$	
R206	Composition, 10 k Ω $\pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm 5\%$	5905-683-2238
R301	Composition, 470 Ω $\pm 5\%$ 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm 5\%$	5905-683-2242
R302	Composition, 4.7 k Ω $\pm 5\%$ 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm 5\%$	5905-686-9998
R303	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$	5905-686-3119
R304	Composition, 18 k Ω $\pm 5\%$ 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm 5\%$	5905-687-0000
R305	Composition, 4.7 k Ω $\pm 5\%$ 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm 5\%$	5905-686-9998
R306	Pot., Comp., 1 k Ω $\pm 30\%$	6049-0106	98474	62PR1K	
R307	Composition, 820 Ω $\pm 5\%$ 1/4 W	6099-1825	75042	BTS, 820 Ω $\pm 5\%$	
R308	Film, 1.78 k Ω $\pm 1\%$ 1/8 W	6250-1178	75042	CEA, 1.78 k Ω $\pm 1\%$	
R309	Composition, 18 k Ω $\pm 5\%$ 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm 5\%$	5905-687-0000
R310	Composition, 3.3 k Ω $\pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm 5\%$	5905-681-9969
R311	Composition, 220 Ω $\pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm 5\%$	5905-683-2240
R312	Composition, 330 Ω $\pm 5\%$ 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm 5\%$	5905-686-3369
R313	Composition, 220 Ω $\pm 5\%$ 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm 5\%$	5905-683-2240
R401	Composition, 10 k Ω $\pm 5\%$ 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm 5\%$	5905-683-2238
R402	Composition, 820 Ω $\pm 5\%$ 1/4 W	6099-1825	75042	BTS, 820 Ω $\pm 5\%$	
R501	Pot., Comp., 10 k Ω $\pm 30\%$	6049-0109	80740	343312100	
R502	Composition, 4.7 k Ω $\pm 5\%$ 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm 5\%$	5905-686-9998
R503	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$	5905-681-6462
R504	Composition, 3.3 k Ω $\pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm 5\%$	5905-681-9969
R505	Composition, 47 Ω $\pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm 5\%$	
R506	Film, 3.01 k Ω $\pm 1\%$ 1/8 W	6250-1301	75042	CEA, 3.01 k Ω $\pm 1\%$	5905-702-5974
R507	Film, 12.1 k Ω $\pm 1\%$ 1/8 W	6250-2121	75042	CEA, 12.1 k Ω $\pm 1\%$	
R508	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$	5905-681-6462
R509	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$	5905-681-6462
R510	Film, 39.2 k Ω $\pm 1\%$ 1/8 W	6250-2392	75042	CEA, 39.2 k Ω $\pm 1\%$	5905-702-5983
R511	Composition, 22 k Ω $\pm 5\%$ 1/4 W	6099-3225	75042	BTS, 22 k Ω $\pm 5\%$	5905-687-0002
R512	Composition, 39 k Ω $\pm 5\%$ 1/4 W	6099-2395	75042	BTS, 39 k Ω $\pm 5\%$	
R513	Composition, 4.7 k Ω $\pm 5\%$ 1/8 W	6098-2475	01121	BB, 4.7 k Ω $\pm 5\%$	
R514	Composition, 470 Ω $\pm 5\%$ 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm 5\%$	5905-683-2242
R601	Composition, 22 k Ω $\pm 5\%$ 1/8 W	6098-3225	01121	BB, 22 k Ω $\pm 5\%$	
R602	Composition, 220 Ω $\pm 5\%$ 1/8 W	6098-1225	01121	BB, 220 Ω $\pm 5\%$	
R603	Composition, 6.8 k Ω $\pm 5\%$ 1/8 W	6098-2685	01121	BB, 6.8 k Ω $\pm 5\%$	
R604	Pot., Comp., 10 k Ω $\pm 30\%$	6049-0109	80740	343312100	
R605	Pot., Comp., 500 Ω $\pm 30\%$	6049-0105	98474	62TR500	
R606	Composition, 3.3 k Ω $\pm 5\%$ 1/8 W	6098-2335	01121	BB, 3.3 k Ω $\pm 5\%$	
R607	Composition, 82 Ω $\pm 5\%$ 1/8 W	6098-0825	01121	BB, 82 Ω $\pm 5\%$	
R608	Composition, 10 Ω $\pm 5\%$ 1/8 W	6098-0105	01121	BB, 10 Ω $\pm 5\%$	
R609	Composition, 27 k Ω $\pm 5\%$ 1/8 W	6098-3275	01121	BB, 27 k Ω $\pm 5\%$	
R610	Composition, 150 Ω $\pm 5\%$ 1/8 W	6098-1155	01121	BB, 150 Ω $\pm 5\%$	
R611	Composition, 2.2 k Ω $\pm 5\%$ 1/8 W	6098-2225	01121	BB, 2.2 k Ω $\pm 5\%$	
R612	Composition, 2.2 k Ω $\pm 5\%$ 1/8 W	6098-2225	01121	BB, 2.2 k Ω $\pm 5\%$	

PARTS LIST (Cont)

REF. NO.	DESCRIPTION	PART NO.	FED. MFG. CODE		MFG. PART NO.	FED. STK. NO.
R613	Composition, 10 Ω $\pm 5\%$ 1/8 W	6098-0105	01121	BB, 10 Ω $\pm 5\%$		
R614	Composition, 5.6 k Ω $\pm 5\%$ 1/8 W	6098-2565	01121	BB, 5.6 k Ω $\pm 5\%$		
R615	Composition, 2.2 k Ω $\pm 5\%$ 1/8 W	6098-2225	01121	BB, 2.2 k Ω $\pm 5\%$		
R616	Composition, 47 k Ω $\pm 5\%$ 1/8 W	6098-3475	01121	BB, 47 k Ω $\pm 5\%$		
R617	Composition, 47 k Ω $\pm 5\%$ 1/8 W	6098-3475	01121	BB, 47 k Ω $\pm 5\%$		
R618	Composition, 150 Ω $\pm 5\%$ 1/8 W	6098-1155	01121	BB, 150 Ω $\pm 5\%$		
R619	Film, 20 k Ω $\pm 1\%$ 1/8 W	6250-2200	75042	CEA, 20 k Ω $\pm 1\%$		5905-702-5971
R620	Film, 20 k Ω $\pm 1\%$ 1/8 W	6250-2200	75042	CEA, 20 k Ω $\pm 1\%$		5905-702-5971
R701	Composition, 47 Ω $\pm 5\%$ 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm 5\%$		
R901	Composition, 430 k Ω $\pm 5\%$ 1/4 W	6099-4435	75042	BTS, 430 k Ω $\pm 5\%$		

INDUCTORS

L101	Inductor, (YE)	1160-2380	24655	1160-2380		
L102	Inductor, (VT)	1160-2400	24655	1160-2400		
L103	Inductor, (BK)	1160-2410	24655	1160-2410		
L104	Inductor, (VT-YE)	1160-2480	24655	1160-2480		
L301	Inductor	1160-2411	24655	1160-2411		
L302	Inductor	1160-8445	24655	1160-8445		
L303	Inductor, 22 μ H $\pm 2\%$	4300-7534	99800	1537-44, 22 μ H $\pm 2\%$		
L501	Inductor, 330 μ H $\pm 10\%$	4300-4300	99800	3500, 330 μ H $\pm 10\%$		
L502	Inductor, 150 μ H $\pm 10\%$	4300-3810	99800	3500-12, 150 μ H $\pm 10\%$		
L602	Inductor, 27,000 μ H $\pm 10\%$	4300-6395	72259	WEE 27,000 μ H		
L603	Inductor, 22,000 μ H $\pm 10\%$	4300-6393	72259	Wee Ductor, 22,000 μ H $\pm 10\%$		
L604	Inductor, 39 μ H $\pm 10\%$	4300-3000	99800	2150-38, 39 μ H $\pm 10\%$		
L701	Inductor, 33 μ H $\pm 10\%$	4300-2900	99800	2150-36, 33 μ H $\pm 10\%$		5950-617-3738
L702	Inductor, 150 μ H $\pm 10\%$	4300-3810	99800	3500-12, 150 μ H $\pm 10\%$		
L703	Inductor, 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$		5950-668-5867
L704	Inductor, 180 μ H $\pm 10\%$	4300-4325	99800	3500, 180 μ H $\pm 10\%$		

TRANSISTORS

Q101	Transistor, (2N3905)	8210-1114	04713	2N3905		
Q102	Transistor, (2N3563)	8210-1066	07263	2N3563		
Q103	Transistor, (2N3563)	8210-1066	07263	2N3563		
Q201	Transistor, (2N3903)	8210-1132	93916	2N3903		
Q301	Transistor, (2N3903)	8210-1132	93916	2N3903		
Q302	Transistor, (2N3903)	8210-1132	93916	2N3903		
Q303	Transistor, (2N3478)	8210-1111	12672	2N3478		
Q304	Transistor, (2N3906)	8210-1112	93916	2N3906		
Q501	Transistor, (2N3563)	8210-1066	07263	2N3563		
Q502	Transistor, (2N3906)	8210-1112	93916	2N3906		
Q503	Transistor, (2N3390)	8210-1077	24454	2N3390		
Q601	Transistor, (2N3906)	8210-1112	93916	2N3906		
Q602	Transistor, (2N3250)	8210-1089	80211	2N3250		5961-945-4108

DIODES

CR201	Diodes,	6082-1016	24446	1N645		5961-944-8222
CR202	Diodes,	6082-1016	24446	1N645		5961-944-8222
CR401	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR402	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR403	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR404	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR405	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR406	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR407	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR408	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR409	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR410	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR411	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR412	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR413	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR414	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR415	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR416	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR417	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR418	Diodes, (1N3604)	6082-1026	99180	1N3604		
CR419	Diodes, (1N758A)	6083-1012	07910	1N758A		
CR501	Diodes,	6084-1006	84411	1N953		
CR601	Diodes, (1N541)	6082-1025	24454	1N541		
CR602	Diodes, (1N541)	6082-1025	24454	1N541		

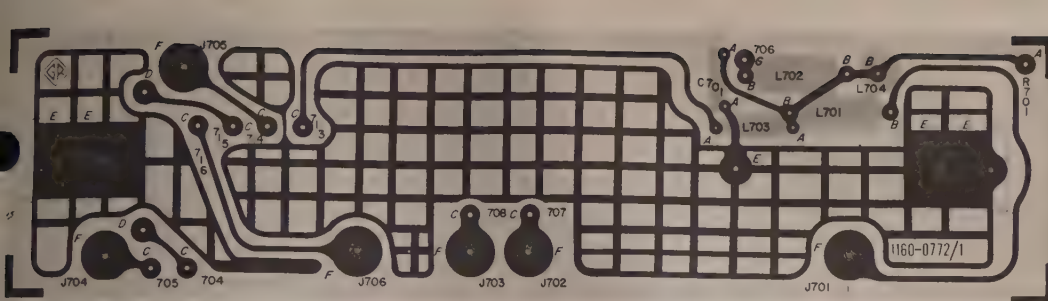


Figure DI-14. Bottom Circuit Assembly etched-circuit board (P/N 1160-2772).

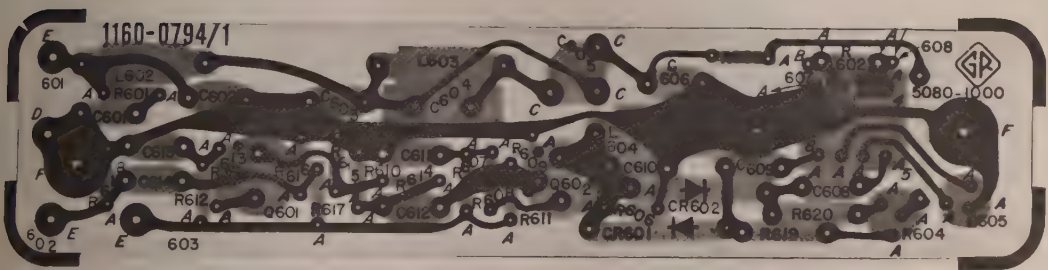


Figure DI-15. Digit Phase Lock etched-circuit board (P/N 1160-2794).

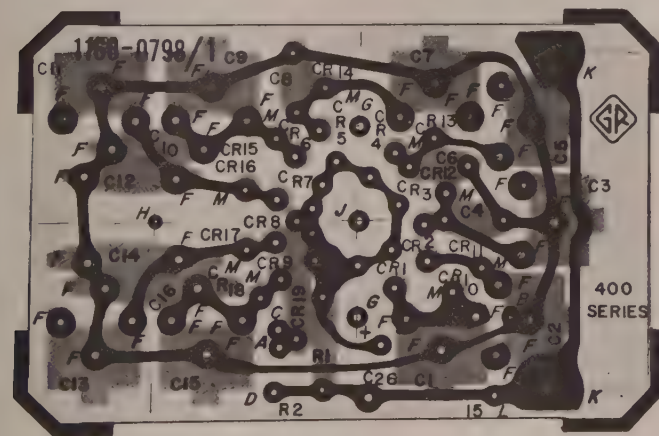


Figure DI-16. Circuits and Switch Assembly etched-circuit board

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

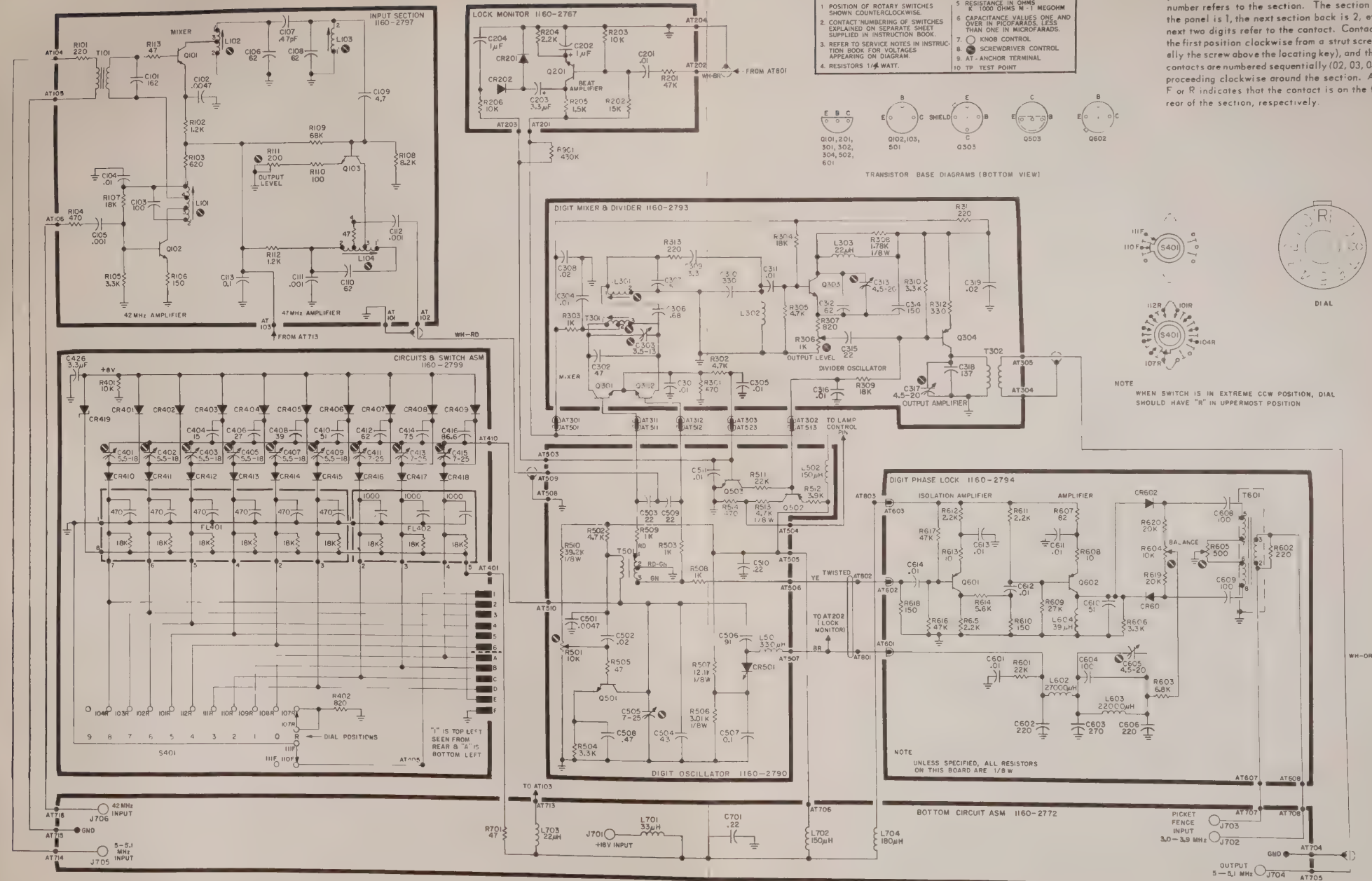
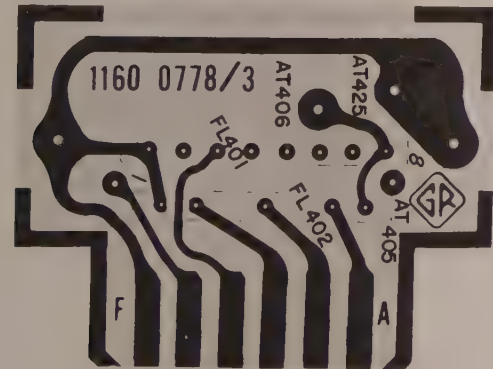


Figure DI-17. Over-all schematic diagram for Remote Digit Insertion Unit (P/N 1160-4006).

PARTS LIST (Cont)

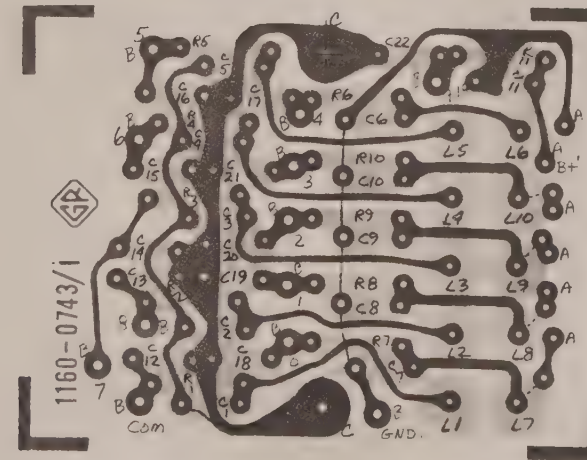
REF. NO.	DESCRIPTION	PART NO.	FED. MFG. CODE	MFG. PART NO.	FED. STK NO.
ETCHED CIRCUIT ASSEMBLIES					
	Lock Monitor Circuit Assembly	1160-2767	24655	1160-2767	
	Bottom Circuit Assembly	1160-2772	24655	1160-2772	
	Filter Circuit Assembly	1160-2778	24655	1160-2778	
	Digit Oscillator Circuit Asm.	1160-2790	24655	1160-2790	
	Digit Mixer and Div. Circuit	1160-2793	24655	1160-2793	
	Digit Phase Lock Circuit Asm.	1160-2794	24655	1160-2794	
	Input Circuit Asm.	1160-2797	24655	1160-2797	
	Digit Selector Circuit Asm.	1160-2798	24655		
JACKS					
J701	Jack	1160-6110	24655	1160-6110	
J702	Jack	1160-6110	24655	1160-6110	
J703	Jack	1160-6110	24655	1160-6110	
J704	Jack	1160-6110	24655	1160-6110	
J705	Jack	1160-6110	24655	1160-6110	
	Jack	4260-1291	70563	380598-1	
NETWORK, PRINTED					
FL401	Network, Printed	1160-0450	24655	1160-0450	
FL402	Network, Printed	1160-0451	24655	1160-0451	
SWITCH					
S401	Switch, Rotary Wafer	7890-5310	24655	7890-5310	
	Switch Asm.	1160-1190	24655	1160-1190	
TRANSFORMERS					
T101	Transformer	1160-2610	24655	1160-2610	
T301	Transformer	1160-2405	24655	1160-2405	
T302	Transformer	1160-2611	24655	1160-2611	
T501	Transformer	1160-2630	24655	1160-2630	
T601	Transformer	5000-2101	24655	5000-2101	



Etched-circuit board of Filter Board, P/N 1160-2778.

FP-1B PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	FED. MFG. CODE	MFG. PART NO.	FED. STK NO.
CAPACITORS					
C1	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C2	thru				
C10	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C11	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C12	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C13	thru				
C21	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C22	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
RESISTORS					
R1	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R2	thru				
R10	Composition, 680 Ω $\pm$ 5% 1/4 W	6099-1685	75042	BTS, 680 Ω $\pm$ 5%	
R11	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
MISCELLANEOUS					
L1	thru				
L10	INDUCTORS, Choke 150 μ H $\pm$ 10%	4300-3810	99800	3500-12, 15 μ H $\pm$ 10%	5950-770-3508
S01	SOCKET	1160-7800	24655	1160-7800	
—	Filter Plug Circuit Asm.	1160-2744	24655	1160-2744	



SERVICE INSTRUCTIONS

section **EA**

CONTINUOUSLY ADJUSTABLE DECADE - CAD-1

P/N 1160-4020

CALIBRATING MIXER - CM-1

P/N 1160-4030

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SECTION EA-1

INTRODUCTION

EA-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension by experienced service personnel of the principles of operation. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate part identification, reference designators used in the text and appearing on the photographs are the same as those used on the complete schematic diagram and in the parts list.

The service instructions rely on use of a properly functioning synthesizer as a basic test frame for individual modules. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the widespread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

EA-1.2 PURPOSE.

EA-1.2.1 CAD FUNCTION.

The Continuously Adjustable Decade, or CAD, like the Digit-Insertion unit, is an element used directly in the generation of a dial-selected output frequency in General Radio synthesizers.

For many applications it is desirable, even in a highly stable signal source, to have the capability to vary frequency continuously rather than in steps, however fine these may be. The CAD provides this continuous coverage. To use the CAD one simply pushes the button under the DI-1 unit where continuous control is desired. The CAD now replaces this DI-1 unit and all others to the right of it. Thus, by simple operation of appropriate pushbutton switches, the CAD can be connected so that one of its 12 major divisions covers frequency increments from 100 kc/s to .001 c/s, depending upon the size of the step-digit replaced.

In addition to manual control by the dial, the CAD frequency can be voltage-controlled. This sweep capability greatly increases the usefulness of the CAD for response plotting and similar applications.

To achieve this versatility, two operational modes, selected by a switch located on the right-hand side of the CAD dial, are available in this unit.

First an INTERNAL LOCK mode provides manual-frequency control by the dial only. In this position, the CAD has superior frequency stability and the dial is accurate to two places; the dial illumination is bright.

In the EXTERNAL CONTROL mode, in addition to the dial setting, frequency control by an external voltage on the EXTERNAL CAD CONTROL binding posts is possible. A level change of 0.3 V (with respect to ground) is required to sweep 1 major CAD division. The resulting reduction in frequency accuracy is signified by the dim dial illumination.

While the CAD produces the same frequency as a DI-1 for corresponding dial settings, its range extends a decade at both ends for greater convenience. Frequencies corresponding to digits -1 and +11 can be covered manually. A range of at least ± 5 major divisions, centered around any position on the dial, is available when voltage tuned.



Two oscillators, with variable ganged capacitors and associated circuitry to perform these functions, are housed in a package dimensionally identical to the DI-1. It is also a convenient plug-in module, self-connecting upon installation. Plug layout is different from that used in the DI-1, and the unit can only be installed in its proper station at the right-hand end of the Main Frame, on top.

EA-1.2.2 CALIBRATING MIXER — CM-1.

In either one of the two modes, the CAD can be quickly calibrated against the primary crystal to at least four places (on its control dial) by means of the Calibrating Mixer. This unit is a small separate assembly mounted behind the CAD on the main deck (four-place calibration requires at least four DI-1 units in the chassis).

EA-1.3 DESCRIPTION.

EA-1.3.1 CAD MODULE.

The Continuously Adjustable Decade, with its cover and dial installed, is shown in Figure EA-1. The external mechanical controls of the unit, the shaft that operates ganged capacitors and the concentric mode-selector switch, are located on the front. The dial, aside from the major divisions corresponding to those of the DI-1 units, has minor divisions (on a panel-mounted scale) to permit direct reading to two digit places. The interpretation of the dial system, which includes the engraving on the lamp holder, is covered in paragraph 3.7 in the front portion of this manual.

The entire CAD assembly is held in the Main Frame by two 4-40 screws that engage the threaded bushings in the top corners of the small front panel, and a hold-down clamp that secures the reinforced bottom of the cover, through a small cutout in the back.

All electrical connections to the CAD are made by banana-type plugs from the Main Frame, through the bottom of the cover into the CAD assembly. The dial light is energized and switch-controlled in the Main Frame as explained in paragraph 4.6 (front portion); it is also controlled in brightness by the mode switch (EXTERNAL CONTROL — INTERNAL LOCK). To achieve this, the crank operating the mode switch contacts a small spring on the lamp-switching card behind the front panel (refer to Sections BA or BB for details).

Two 4-40 screws on either side of the unit fasten the cover to the CAD unit frame structure. After their removal, the unit may be withdrawn from the cover by holding the case in one hand and pulling the unit by the capacitor shaft with the other.

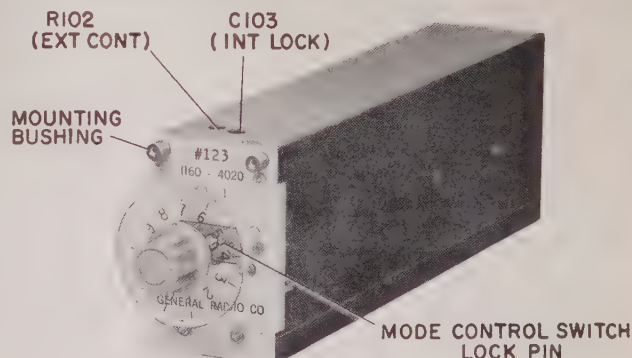


Figure EA-1.

Continuously Adjustable Decade CAD module.

The circuitry of the CAD is contained on four etched-circuit boards. They are the longer (horizontal) top and bottom boards and the smaller (vertical) front and rear circuit boards. These boards mount most of the components and provide for connections between them. The circuit boards are joined to the ganged-capacitor assembly through the side rails and the front panel, thus forming the structure of the CAD.

Four banana-plug receptacles are located in the bottom board and two in the ganged-capacitor assembly. These furnish the electrical connections.

Signal flow and circuit layout are arranged so that a minimum of wiring between boards is required. Each circuit-board assembly can be removed from the structure after connecting-wire leads are unsoldered and appropriate screws removed. There is, however, enough space in almost all instances to permit removal of components from the board directly. It is important to take special precautions to protect the capacitor plates from damage or deformation.

The side rails of the top and bottom boards are equipped with special ground springs to ensure intimate contact with the cover. The four threaded inserts, which accept the 4-40 screws holding the cover, establish fixed-contact areas between the horizontal shield partition and cover. A finger-stock rf seal secures the junction of the cover and the CAD front panel.

EA-1.3.2 CM-1 MODULE.

The Calibrating Mixer is a small separate unit that mounts behind the CAD on the upper deck. It contains a single etched board to which small side rails are joined. The etched-circuit board is equipped with an integral edge-type plug, which engages a receptacle on the chassis. The cover, which is attached to the side rails, holds the unit down by means of three 4-40 screws into the deck.

SECTION EA-2

PRINCIPLES OF OPERATION

EA-2.1 SIGNAL FLOW.

EA-2.1.1 GENERAL.

The main circuits of the CAD are shown in the block diagram, Figure EA-2. (Refer also to the schematic diagram, Figure EA-11, in which the four circuit boards are distinguished by heavy outlines.) In accordance with the flow in the synthesizer itself, where the signal is fed from DI-1 to DI-1 (or from the CAD to a DI-1), from right to left, the main signal flow in the block diagram is from right to left along the horizontal axis of the figure. This signal flow pertains to the INTERNAL LOCK mode of operation, in which all blocks shown are active (covered in detail in paragraph EA-2.1.3).

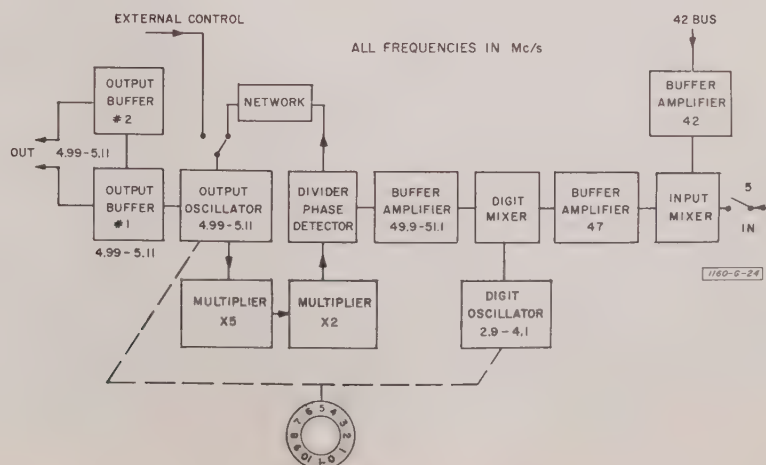
EA-2.1.2 EXTERNAL CONTROL MODE.

The CAD can "replace" any DI-1 in the 1160-series synthesizers and it must therefore produce

output frequencies between 5.0 and 5.1 Mc/s. The free-running Output Oscillator is tuned through this band by one section of a ganged capacitor; in addition, a varactor diode is employed in the tank circuit. The narrow frequency range makes a nearly linear voltage control possible. A control voltage of 0.3 V applied to the varactor changes frequency 10 kc/s or one major division on the dial (one step on a DI-1). Coupling of this voltage from the EXTERNAL CAD CONTROL binding posts is dc, so that angle modulation, frequency shift, or phase locking is possible. The center frequency is still controlled by the dial-driven variable capacitor.

In this mode, the output oscillator and the output buffer on the left in the block diagram are the only active components. Frequency coverage is 4.99 to 5.11 Mc/s, which in terms of digits gives a coverage of -1 to +11 (rather than 0-9). These overlaps are convenient for searching.

Figure EA-2.
Block diagram of CAD set for
INTERNAL LOCK mode operation.



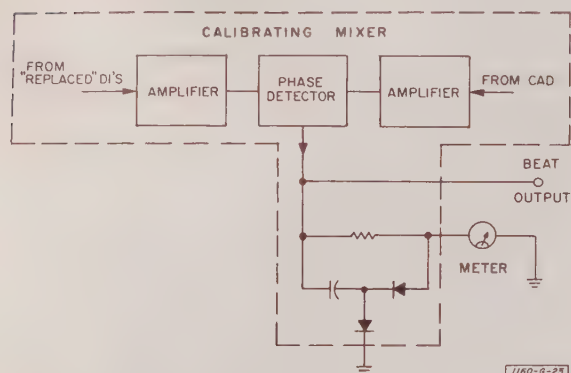


Figure EA-3.
Block diagram for Calibrating Mixer - CM-1.

EA-2.1.3 INTERNAL LOCK MODE.

Two-figure accuracy on the CAD dial calls for parts-in- 10^5 oscillator stability. In order to attain such performance, the phase-lock capability available in the 5.0-Mc oscillator, just described, is used in a second operating mode, the INTERNAL LOCK mode. Here oscillator stability is increased by approximately a factor 10. To do this the major part of the output frequency is crystal controlled (47 Mc/s) and only a small part stems from a free-running Digit Oscillator (2.9–4.1 Mc/s). The circuit is very similar to one in the DI-1 and uses the same crystal-controlled frequencies produced in the AFS.

The block diagram shows the same input circuits as used in the DI, where 5.0 and 42 Mc/s are added and fed to a second mixer via an amplifier. Instead of heterodyning with a 3.00–3.90-Mc step-tuned, phase-locked oscillator, a 2.900–4.100-Mc oscillator, tuned by the second section of the ganged capacitor mentioned earlier, is used. The mixer output of 49.90–51.10 Mc/s is routed to a phase detector through a double-tuned amplifier, and the same process of division is used as described for the DI-1. The varactor used for external control of the 5.0-Mc oscillator can also be used to phase-lock the oscillator, totally eliminating its instability. Drifts of the 2.9–4.1-Mc oscillator are divided by 10.

A second output amplifier feeds the Calibrating Mixer, which is covered in paragraph 2.1.4.

EA-2.1.4 CALIBRATING MIXER - CM-1.

This mixer is a convenient means of checking the accuracy of the CAD frequency. As will be recalled, the CAD replaces all DI-1's to the right and the one above any depressed front-panel button. The replaced DI-1's are no longer contributing to the synthesizer output, but they are operative. The Calibrating Mixer allows comparison of the CAD output with the locked frequency of these DI's.

Figure EA-3 shows that this mixer consists of two amplifiers and a phase detector (see also the schematic diagram, Figure EA-13). The front-panel meter can be connected to this mixer to display slow beats directly. An additional network gives a meter indication (proportional to frequency) for beat frequencies above a few hundred cycles, so that zero

beat may be found by first tuning for a minimum on the meter. A one-cycle beat represents an inaccuracy of 1 in the fifth position, so that a calibration to four meaningful figures is possible.

The mixer output is also available on front-panel binding posts; it is particularly useful in the generation of markers for calibration of sweep displays.

The interconnection of the two modules is shown in the schematics of Sections BA and BB.

EA-2.2 CIRCUIT DETAILS.

EA-2.2.1 INTRODUCTION.

Circuit operations and the location of prominent components will be discussed in the sequence in which the signal originates and passes through a Continuously Adjustable Decade and the Calibrating Mixer. Reference will be made to the Figures EA-2 and EA-3, as well as the over-all schematic diagrams Figure EA-11 and EA-13.

EA-2.2.2 OUTPUT-OSCILLATOR/AMPLIFIER.

This section is used in the EXTERNAL CONTROL mode directly. In the INTERNAL LOCK mode, it is used in conjunction with other circuitry in the CAD.

The output signal of 4.99–5.11 Mc/s is generated in a Colpitts oscillator (Q401). The tuned circuit includes C102, the variable capacitor operated by the dial control, the varactor diode CR401, for voltage control of the oscillator frequency, and a trimmer C406. The main output amplifier, Q402, is a broadly tuned common-emitter stage loosely coupled to the oscillator. The output voltage of approximately 0.30 V is fed to J404, the output of the CAD unit. The output signal is also applied to Q403, which is an untuned buffer amplifier feeding the Calibrating Mixer through J403.

The output circuits described above occupy the bottom circuit board located behind the ganged capacitor.

EA-2.2.3 INPUT SECTION.

A grounded-emitter stage, Q207, with a tuned output coil, serves as isolator, amplifier, and impe-

dance transformer for the 42-Mc signal that is taken from the 42-Mc bus (fed by the AFS through J401) and injected into the Input Mixer. The input of the 42-Mc buffer is of moderately high impedance and broadly tuned.

In the INTERNAL LOCK mode, the Input Mixer combines the incoming 5.0-Mc signal from J101 and the 42-Mc signal from the buffer. The 5.0-Mc input, of approximately 0.30 V, is stepped-up in T201 and applied to Q201 and Q202. The connection between L207-4 and T201-1 feeds the 42-Mc signal to the transistors in phase and also completes the bias circuit. The balanced configuration, together with the circuit (T202, C204, C205) tuned to the upper sideband (47 Mc/s), effectively eliminates the 42-Mc component in the output and provides substantial rejection for the ninth-harmonic component of the 5-Mc input signal. Q203 is a transformer-coupled buffer-amplifier, which amplifies the 47-Mc signal before application to the Digit Mixer. Its tuned output coil, L202, contributes further selectivity for the suppression of unwanted mixer-output components.

The input circuits described above occupy the front part of the top circuit board.

EA-2.2.4 DIGIT OSCILLATOR, MIXER, AND BUFFER.

A tap on L202 brings the 47-Mc signal from the Q203 buffer stage to the junction of C214 and C215, which forms the input to the Digit Mixer. The second signal into this mixer is the Digit Oscillator output of 2.9 – 4.1 Mc/s. Although continuously tuned in the CAD unit, the term Digit Oscillator is used here too because of the analogy with the Digit Oscillator in the DI-1 unit.

Q208 is the active element in the Digit Oscillator, which includes T205, C234, and C233. Tuning is effected by C101, in the main section of the ganged capacitor, and trimmer C103, located on the front board. The two-phase oscillator output is applied to the Digit Mixer via R220 and R221.

The Digit Mixer output of 49.9 – 51.1 Mc/s (47 + 2.9 to 4.1 Mc/s) is filtered in the tuned circuit T203/C213 and applied to the following buffer, Q206. To obtain an equalized output over the 1.2-Mc bandwidth, a double-tuned filter (compensating the response of the preceding single-tuned circuit) couples the signal into the Divider Phase Detector.

The Digit Oscillator, Digit Mixer and buffer circuits are located on the top board in the middle.

EA-2.2.5 MULTIPLIER CIRCUITS AND PHASE LOCK.

The backboard in the CAD unit contains the X10 Multiplier circuits for the output-oscillator frequency.

The two transistors, Q302 and Q301, perform the function of a quintupler and doubler, respectively. Both are class-C multipliers with circuits tuned to the desired harmonic of the input frequency in the collector circuits. L301 and L302 are resonated at approximately 25 Mc/s and T301/T204 are tuned to about 50 Mc/s.

The above circuits, from the Output Oscillator through the Multiplier into the Divider Phase Detector (a conventional half-bridge circuit), and from its output through filter circuits back to the varactor diode (CR401), form a phase-lock circuit. Once captured, the oscillator frequency is kept at exactly 1/10th of the reference frequency (49.9 – 51.1 Mc/s) by a dc voltage applied to the varactor diode. This voltage is developed in the phase detector. If a different dc voltage is required on the varactor diode, to compensate for circuit drifts in the oscillator for instance, only the relative phases of the two inputs to the phase detector change.

Potentiometer R102, an externally accessible control at the top of the unit, sets the initial back-bias for the varactor diode and therefore affects the free-running oscillator frequency.

During the process of "capture" (the synchronization of the oscillator frequency with the reference frequency), the oscillator is frequency-modulated initially with the frequency difference between the reference and its own frequency multiplied by ten. Sidebands of this modulation have to be passed by the multiplier circuits and they are therefore considerably wider in bandwidth than 4.99 – 5.11 Mc/s (or 49.9 – 51.1 Mc/s) would suggest.

EA-2.2.6 FRONT CIRCUIT BOARD.

Reference has been made in various paragraphs above to the front circuit board, which contains the mode switch, S402, potentiometers R102 and R105, trimmer C103, and various associated parts.

The mode switch (lever on the right of the CAD dial with coaxial actuator), as has been mentioned before, selects one of the two operating modes of the CAD according to the desired application.

If frequency control by external voltage is desired, the EXTERNAL CONTROL mode is selected and only the Output-Oscillator amplifier section of the CAD is activated. The switch removes the 5-Mc input from T201, connects the EXTERNAL CONTROL voltage from J102 through filtering circuits to one side of the varactor diode, CR401. R105 permits adjustment of the sensitivity for external frequency control to a nominal value of -0.3 V for plus one major CAD division (10 kc/s). The cathode terminal of the varactor is connected to R102, establishing the back bias. Besides electronic frequency control, the dial (through C102) is used to set the frequency of the CAD.

In the INTERNAL LOCK mode, R104 keeps the anode of the varactor at ground potential, while the cathode is connected to the Divider Phase-Detector output. Since the 5-Mc input signal is now also connected, the output oscillator is phase-locked through the X10 multiplier to the 49.9 – 51.1-Mc reference signal. It is easily seen that a 100-kc change in the Digit Oscillator produces a 10-kc change in the output oscillator, and that digit-oscillator drift is reduced in the same way. The output oscillator, which is now only pretuned by C102 (ganged with C101), does not contribute to the output frequency instability in this mode.



EA-2.2.7 CALIBRATING MIXER—CM-1.

Schematic diagram Figure EA-13 shows the CAD Calibrating Mixer employing two amplifiers, Q101 and Q102 (in the grounded-emitter configuration), and a half-bridge mixer. The amplifiers supply the power gain needed to drive the meter circuit, while maintaining isolation to prevent a feedthrough from the "Mix" or Reference-Line fed by the replaced DI-1's to the CAD output.

CAD output #2 is present continuously at pin A₁ of PL101 of the CM-1 unit. The output frequency of the replaced DI-1's enters at pin F6 of PL101, whenever the CAD is activated. When both inputs are

present simultaneously, the CM-1 compares them and the result of the comparison is its output.

The Mixer Output is dc-connected to the BEAT terminals on the front panel, where it may be used for calibration, marker generation, or phase locking.

The MONITOR meter (through the front-panel switch) is connected to the Mixer Output, to display slow-beat frequencies between the CAD frequency and the frequency of the replaced DI-1 units. As an aid in finding the slow beat, a frequency-sensitive detector circuit is inserted to rectify the beat frequency and produce a meter deflection to the right that increases with frequency.

SECTION EA-3

SERVICE AND MAINTENANCE

EA-3.1 INTRODUCTION.

EA-3.1.1 GENERAL.

Just as the CAD unit can be used in the system self-check procedures (refer to paragraph 5.3) to test the DI-1 modules, properly functioning DI-1 units and the AFS unit can serve in a synthesizer to test the CAD, when used in conjunction with the Calibrating Mixer. Many such tests can be performed without instrument disassembly. As will be recalled, the Calibrating Mixer compares the output frequency of the CAD unit directly with the output of one or a series of several DI-1 units.

EA-3.1.2 TEST EQUIPMENT.

Table EA-1 lists and describes tools and test equipment recommended for the procedures which follow in this section. Equivalents may be substituted.

EA-3.2 TROUBLE ANALYSIS—EXTERNAL.

EA-3.2.1 GENERAL.

External service procedures do not require removal of the CAD or CM-1 modules from the Main Frame chassis, but do require that the synthesizer be removed from its cabinet and be set up in normal operating position, with usual line-power input. Front-panel controls and indicators on the synthesizer (assumed to be otherwise in good working order) will suffice at this level.

There are two basic failure modes possible in the CAD and CM-1. They are:

1. Output missing or low.
2. Poor frequency control.

NOTE

Unless the CAD is used as the electrical "replacement" of the left-most DI-1 unit, absence of the CAD output will not result in loss of synthesizer output.

TABLE EA-1
TEST EQUIPMENT

<u>Function</u>	<u>Type Recommended</u>	<u>Minimal Characteristics</u>
Electronic Voltmeter (VTVM)	GR 1806-A (with Type 1806-P1 probe)	BW 1-55 Mc/s; sensitivity 0.2 V; probe capacity 2.0 pF maximum.
Voltage source, variable	—	0-2 Vdc continuous; 1.0 mA, minimum; internal resistance <10Ω.
Patch cord	274-NQ	Coaxial, double plug for binding post.
Adjustment tool	JFD #5284	Minimum metallic contact with screw slot; insulated shaft.

EA-3.2.2 OUTPUT MISSING OR LOW.

Lack of CAD output is detected most easily by absence of front-panel MONITOR meter deflection. Check this in the CAD-CAL mode, as the CAD frequency is adjusted by the dial, with the button under the CAD unit depressed. A meter reading in this condition indicates that the CAD produces an output.

If no meter deflection can be obtained, a further convenient check can be made to isolate the trouble between the CAD and the Calibrating Mixer (CM-1).

Depress the button under the left most DI-1 unit (station 1) and observe the signal at TP102 with the VTVM. TP102 is accessible on the left-hand side pan of the synthesizer chassis. A reading of 0.3 V, rms, at approximately 5 Mc/s (with the CAD dial set at 0) should be obtained.

If the reading is normal, the CAD is probably functioning properly and the CM-1 is defective; refer to paragraph EA-3.7 for detail trouble analysis on that unit. There is also the possibility that Output Buffer #2 in the CAD is faulty. To distinguish between this and a CM-1 failure, remove the CM-1 and

connect the VTVM to pin 1 of SO201 on the Main Frame deck. A voltage of approximately 0.3 V, rms, should be present. If the reading is abnormal, proceed to the internal trouble-analysis procedures for the CAD, paragraph EA-3.4.

EA-3.2.3 POOR FREQUENCY CONTROL.

With the button under the CAD depressed and the digit steps set to 0, a variation of the CAD frequency-dial setting, near the zero mark, should produce a minimum in the meter indication. By careful further adjustment, a visible beat of a few cycles per second should be obtained. In the EXTERNAL CONTROL mode, deviations from the zero dial setting up to ± 3 small divisions may be required, depending upon instrument temperature. In the INTERNAL LOCK mode, the beat should be obtained within ± 0.5 small divisions from zero. If beat cannot be achieved within these limits, refer to paragraph EA-3.3 for corrective adjustments.

EA-3.3 EXTERNAL ADJUSTMENTS.

EA-3.3.1 GENERAL.

Three secondary controls, accessible through the cover of the CAD unit, can be adjusted with an insulated screwdriver, with the unit remaining in its normal operating position on the synthesizer. If either of the following procedures cannot be completed successfully, refer to paragraph EA-3.4.

EA-3.3.2 MANUAL CONTROL.

CAD oscillator drift may necessitate adjustment of frequency to re-establish exact correlation with the dial. After the instrument cabinet has been removed, R102 and C103 are accessible through the top of the CAD cover. The procedure is as follows:

- Compare the CAD output frequency with that of the neighboring DI-1 unit in the "5" position, by pressing the button under that DI-1 and setting the MONITOR switch to the CAD-CAL position.
- Place the mode selector in the EXTERNAL CONTROL position and set the dial to 5.00.
- Adjust R102 to obtain a slow beat (< 10 c/s) on the meter.
- Repeat the procedure in the INTERNAL LOCK mode, except use C103 for the adjustment.

EA-3.3.3 ELECTRICAL CONTROL.

The EXTERNAL CAD CONTROL voltage sensitivity can be adjusted by use of R105, which is accessible through a cutout in the adjacent side pan of the Main Frame chassis. After setting R102 in accordance with paragraph EA-3.3.2, proceed as follows:

- Set the DI-1 (next to the CAD) to digit "6".
- Apply a voltage of -0.3 Vdc, from the external source to the EXTERNAL CAD CONTROL binding post.
- Look for a slow beat on the meter.
- Adjust R105 for a minimum meter indication and, with careful adjustment, achieve a slow beat (< 10 c/s).

EA-3.4 CAD TROUBLE ANALYSIS - INTERNAL.

EA-3.4.1 GENERAL.

If the CAD output is abnormal, or poor frequency control cannot be compensated by the adjustment procedures of paragraph EA-3.3, remove the unit from the chassis and replace it with another CAD, if available. Otherwise, replace it with a CAD bridging unit or equivalent; refer to paragraph 5.5 in the front portion of the book. Return the defective CAD to General Radio Company for service.

If the faulty CAD unit cannot be returned, certain further tests can be made in the field. However, a thorough comprehension of the principles of operation (Section EA-2) is essential. The following procedures will permit isolation of the fault within the CAD, so that corrective measures can be taken. Turn instrument power off and remove the CAD unit from the synthesizer to permit cover removal; refer to paragraph EA-3.5. Remove the two screws in each side of the unit to release the cover. Grasp the tuning-control shaft in one hand and pull the cover off the back of the unit with the other.

Reinstall the open CAD on the synthesizer and remount the mode-switch lever in the EXTERNAL CONTROL position. Make sure that the tuning dial is at its fully CW position and remount the dial knob so that it reads exactly 11.

Turn power on and follow the procedural steps given in Table EA-2 to isolate trouble to a defective stage. At that point, reference to Table EA-3 should also aid in isolation of a defective detail part.

The test points called out are identified in Figures EA-4 and EA-5; for the most part they are accessible along the top of the module. Those few required test points that are not on the top are accessible through the opening in the right-hand side pan of the synthesizer chassis.

CAUTION

Do not bend the plates of C101 or C102 and do not short the +18-V supply to ground with the VTVM probe.

Synthesizer controls must be placed in the following setting before the procedures of Table EA-2 are undertaken:

POWER - on
MONITOR - CAD CAL
Step digits - 0 (all units)
CAD mode - INTERNAL LOCK
CAD dial - 5.00
CAD pushbutton - depressed

EA-3.5 REMOVAL OF CAD FROM CHASSIS.

CAUTION

The power switch must first be OFF, or preferably, the power cord should be disconnected.

Each CAD unit is held in place by two front-panel screws (concealed under the dial strip at the top of the panel) and by a hold-down clamp in the deck at the



TABLE EA-2

CAD INTERNAL TROUBLE ANALYSIS
(Figure EA-4, EA-5 and EA-11)

<u>Step</u>	<u>Circuit</u>	<u>Test Point</u>	<u>Normal Indication*</u>	<u>If Indication Abnormal</u>
1	B+	AT209	18 $\pm$ 0.2 Vdc	Check Main Frame and Power-Supply module.
2	Output Oscillator	TP401 (C102 rotor)	6.5-8.5 V, rms	Refer to Table EA-3.
3	5-Mc Input	AT204	0.25-0.40 V, rms	Check Main Frame and AFS module.
4	42-Mc Input	AT201	0.8-1.1 V, rms	Check Main Frame and AFS module.
5	42-Mc Buffer	TP201	0.4-0.8 V, rms	Refer to Table EA-3.
6	Input Mixer	TP202	0.5-0.7 V, rms	Refer to Table EA-3.
7	47-Mc Buffer	TP203	2.5-3.5 V, rms	Refer to Table EA-3.
8	Digit Oscillator	TP205	11-14 V, rms	Refer to Table EA-3.
9	Digit Mixer	TP206	0.4-0.7 V, rms	Refer to Table EA-3.
10	49.9-51.1 Mc Buffer	TP207	5.0-6.0 V, rms	Refer to Table EA-3.
11	X5 Multiplier	TP301	1.8-2.3 V, rms	Refer to Table EA-3.
12	X2 Multiplier	TP208	3.0-5.0 V, rms	Refer to Table EA-3.

*All taken with Type 1806-A with Type 1806-P1 probe.

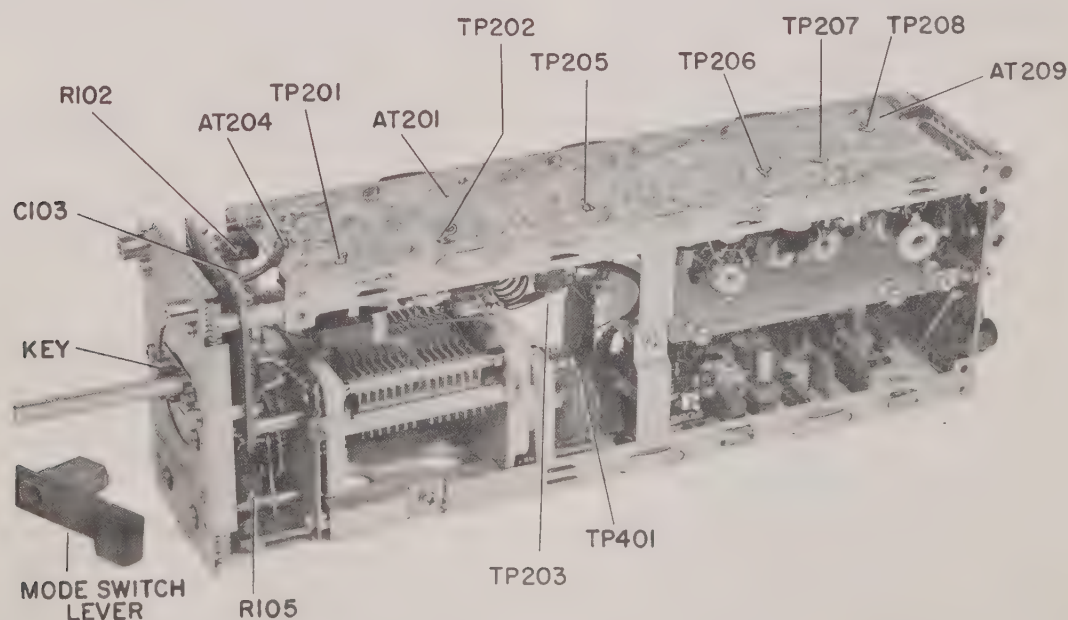


Figure EA-4. Front oblique view of CAD, top side.

TABLE EA-3
CAD DC VOLTAGE READINGS

<i>Stage</i>	<i>Emitter</i>	<i>Base</i>	<i>Collector</i>
Q201	17.9	17.2	0
Q202	17.9	17.2	0
Q203	0.95	1.46	17.5
Q204	0.8	-.1	17.7
Q205	0.8	-.1	17.7
Q206	1.60	1.95	17.3
Q207	0.75	1.35	17.8
Q208	15.8	16.0	0
Q301	2.5	0	17.0
Q302	2.6	0	17.3
Q401	16.1	16.1	0
Q402	17.3	17.0	0
Q403	16.7	16.4	10.0

NOTES:

Unit operating with all inputs, installed in chassis, no cover.

Voltages measured in the INTERNAL LOCK mode with Type 1806-A in dc positions.

These are typical readings and they are somewhat dependent on rf signal levels.

Variations of $\pm 15\%$ are to be expected.

rear of the unit. To remove the unit, proceed as follows:

a. Remove the dial strip, which is held in place by the two Phillips-head screws.

b. Loosen the two Allen-head setscrews in the knob, by use of a 3/32-inch hex wrench, and remove the dial. Then pull the dial lamp holder forward out of the panel. (There is a threaded insert in the top center of the lamp holder into which a 4-40 screw can be inserted to serve as a handle).

c. Pull the EXTERNAL CONTROL/INTERNAL LOCK switch lever off the shaft.

d. Release the rear clamp, using a straight-bladed screwdriver in the slot of the clamp screw. Turn counterclockwise until the clamping bar swings out of the recess in the rear of the unit. (To reinstall the unit, it may be necessary to take an additional turn or two counterclockwise, in order to raise the clamping bar high enough to swing freely into the recess, when the clamp screw is tightened clockwise.)

e. Grasp the unit by its shaft and at the rear and lift vertically for about 5/8 inch until the banana plugs are disengaged. Then continue to raise the rear and angle the unit out.

CAUTION

Position the mode switch at EXTERNAL CONTROL before removal or remount; otherwise, the leaf-spring contact which controls lamp dimming may be damaged.

NOTE

To reinstall the CAD dial, turn the shaft clockwise to the stop. Then install the dial to read "11" (i.e., set the dial line marked "10" at the lamp holder dial line marked "1", for proper dial registration).

EA-3.6 REPAIR AND REPLACEMENT.

If the CAD internal-trouble-analysis procedures disclose defective detail parts, turn off synthesizer power, dismount the CAD, and remove the defective parts. It should not be necessary to disassemble the unit further, to remove replaceable parts.

NOTE

In any event, replacement must be limited to non-frequency determining parts, because special fixtures are required to permit realignment of tuned circuits that have been altered.

Figure EA-5 shows the relative positions of the four etched-circuit boards upon which most CAD parts are mounted. Callouts on that figure refer to composite views of the circuit boards (which are presented in Figures EA-7 through EA-10) that give the exact locations of the parts.

Reference designators used on the photos and printed on the circuit boards are the same as those appearing on the over-all schematic diagram, Figure EA-11, and used in the parts list given at the end of this section.

EA-3.7 CM-1 SERVICE.**EA-3.7.1 GENERAL.**

If a 0 (center-scale) deflection on the front-panel MONITOR meter could not be obtained, as called for in paragraph EA-3.2.3, and the CAD has been determined to be in proper operating condition, the Calibrating Mixer is out of adjustment or has defective parts. Procedures that follow should permit satisfactory readjustment, or facilitate isolation of the defective circuit for repair or replacement. Refer to Figures EA-12 and EA-13; reference to the schematic diagrams for the appropriate Main Frame (Section BA or BB) should also prove helpful for interconnecting wiring between modules.

EA-3.7.2 BALANCE ADJUSTMENT.

With the MONITOR meter switch in the CAD CAL position, the CAD OFF pushbutton depressed, and the CAD dial set at 0, adjust R105, accessible through the top of the CM-1 cover, for a 0 meter indication. If the R105 adjustment does not accomplish the desired effect, continue below.

EA-3.7.3 DETAIL TROUBLE ANALYSIS (Figure EA-6).

To isolate malfunction to a particular stage of the Calibrating Mixer, the unit must first be removed from the synthesizer and its primary inputs checked.

CAUTION

Do not remove or install a CM-1 with synthesizer power on.

To do this, proceed as follows:

a. Release the three hold-down screws and pull up on the unit to unplug it from SO201, its multipin connector on the top deck of the Main Frame chassis.

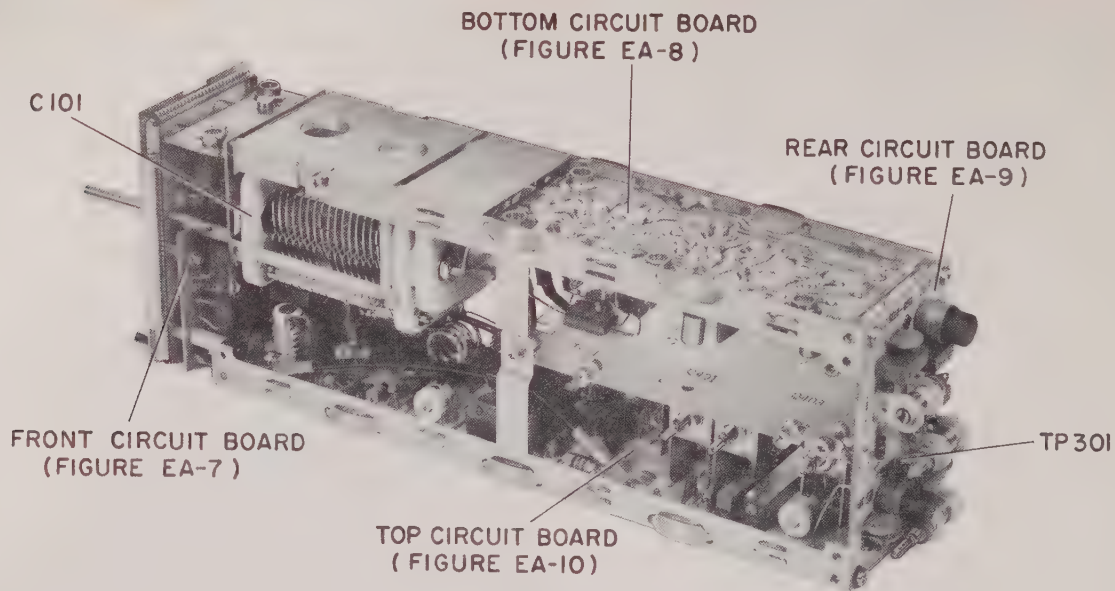


Figure EA-5. Rear oblique view of CAD, bottom side up.

b. Substitute the CAD for any DI-1 module by operation of the appropriate front-panel pushbutton.

c. With the VTVM, measure voltages at three pins on the vacant SO201 (with respect to chassis ground):

pin 1 ---- ≈ 0.20 to 0.35 V, rms
 pin 6 ---- ≈ 0.30 to 0.45 V, rms
 pin 2 ---- $+18 \pm 0.2$ Vdc

NOTE

Rotate the digit-selector control of the "replaced" DI-1 through all positions when observing the input at pin 6. If the signal drops out at any position, the trouble is not in the CM-1 but in the DI-1 or the Main Frame.

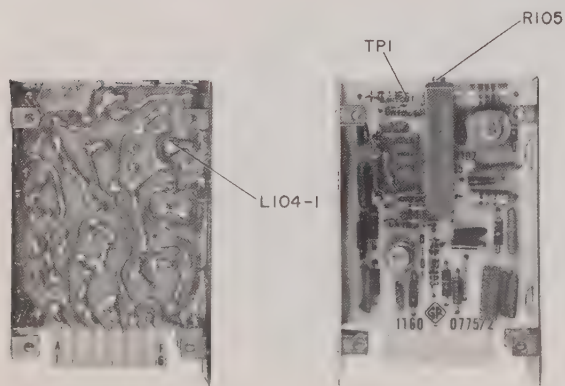


Figure EA-6.

Calibrating Mixer internal test points and secondary adjustments.

TABLE EA-4

CM-1 DC READINGS
(Figure EA-12)

Stage	Emitter	Base	Collector
Q101	14.6	14.3	0
Q102	14.6	14.3	0

NOTES:

Unit installed in chassis, operating without cover.
 Meter — Type 1806-A dc position.

Reading variations of $\pm 10\%$ are to be expected.

If the above voltages are normal, the fault must be in the Calibrating Mixer, intermodule wiring, or in the MONITOR meter circuit.

To isolate defects within the CM-1 unit proceed as follows:

a. Remove the eight 4-40 screws that attach the cover to module and slide the cover off.

b. Plug the module into SO201, with the component side of the board facing the front of the synthesizer.

c. Depress the CAD OFF button and look for 3.0 to 4.0 V, rms, at TP1, the junction of CR101, CR102 and L103.

d. Depress the button under any DI-1 unit and look for 3.0 to 4.0 V, rms, at terminal 1 of L104 (accessible from the foil side).

If either of the above indications is abnormal (with proper inputs present to the module), refer to Table EA-4 to check the dc operating voltages at the transistor stages.

EA-3.7.4 REPAIR AND REPLACEMENT.

Repair or replace defective parts. Use Figures EA-6, EA-12 and EA-13, together with the parts list for the CM-1 unit, to identify detail parts.

ELECTRICAL PARTS LIST

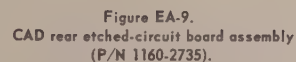
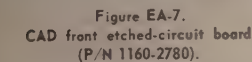
Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C101	Variable, ganged	Part of 1160-2900			
C102	Variable, ganged	Part of 1160-2900			
C103	Trimmer, 5.5 to 18 pF 350 V	Part of 1160-2900			
C104	Ceramic, 0.001 μ F +80-20% 500 V	Part of 1160-2900			
C105	Ceramic, 0.022 μ F +80-20% 500 V	Part of 4407-3329	14655	22A, 590 pF $\pm$ 2%	
C201	Mica, 590 pF $\pm$ 2% 300 V	4700-0730	14655	22A, 590 pF $\pm$ 2%	
C202	Mica, 590 pF $\pm$ 2% 300 V	4700-0730	72982	831, 470 pF $\pm$ 10%	
C203	Ceramic, 470 pF $\pm$ 10% 500 V	4404-1478	72982	538-006, 7-25 pF	
C204	Trimmer, 7 to 25 pF 350 V	4910-2032	72136	CM15E, 100 pF $\pm$ 2%	
C205	Mica, 100 pF $\pm$ 2% 500 V	4650-0201	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C206	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	5C13, 0.22 μ F $\pm$ 20%	5910-974-5694
C207	Ceramic, 0.22 μ F $\pm$ 20% 25 V	4400-2052	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C208	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	72982	538-006, 5.5 to 18 pF	
C209	Trimmer, 5.5 to 18 pF 350 V	4910-2031	14655	22A, 62 pF $\pm$ 5%	
C210	Mica, 62 pF $\pm$ 5% 500 V	4700-0364	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C211	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100			
C212	Ceramic, 0.001 μ F +80-20% 500 V	Part of 1160-2231	72982	538-006, 7-25 pF	
C213	Trimmer, 7 to 25 pF 350 V	4910-2032	72136	CM15, 22 pF $\pm$ 10%	
C214	Mica, 22 pF $\pm$ 10% 500 V	4620-0151	72136	CM15, 22 pF $\pm$ 10%	
C215	Mica, 22 pF $\pm$ 10% 500 V	4620-0151			
C216	Ceramic, 0.001 μ F +80-20% 500 V	Part of 1160-2231	72982	831, .001 μ F +80-20%	5910-983-9994
C217	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, .001 μ F +80-20%	5910-983-9994
C218	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109			
C219	Mica, 33 pF $\pm$ 5% 500 V	Part of 1160-2271	78488	GA, 1 pF $\pm$ 10%	5910-981-3425
C220	Ceramic, 1 pF $\pm$ 10% 500 V	4400-0100	24655	1160-2271	
C221	Mica, 33 pF $\pm$ 5% 500 V	1160-2271	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C222	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C223	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	14655	22A, 10 pF $\pm$ 5%	
C224	Mica, 10 pF $\pm$ 5% 500 V	4700-0203	14655	22A, 10 pF $\pm$ 5%	
C225	Mica, 10 pF $\pm$ 5% 500 V	4700-0203	72982	538-006, 7-25 pF	
C226	Trimmer, 7 to 25 pF 350 V	4910-2032			
C227	Mica, 33 pF $\pm$ 5% 500 V	Part of 1160-2211	72982	831, .001 μ F +80-20%	5910-983-9994
C228	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72136	CM15E, 90.0 pF $\pm$ 2%	
C229	Mica, 90.0 pF $\pm$ 2% 500 V	4650-0170	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C230	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80183	5C13, 0.47 μ F $\pm$ 20%	5910-974-5696
C231	Ceramic, 0.47 μ F $\pm$ 20% 25 V	4400-2054	01121	35-203W, 0.02 μ F	
C232	Ceramic, 0.02 μ F +80-20% 50 V	4402-3200		+80-20%	5910-952-8659
C233	Ceramic, 56 pF $\pm$ 5% 500 V (N330)	4415-0565			
C234	Mica, 0.0015 μ F $\pm$ 5% 100 V	4700-0690	14655	22A, 0.0015 μ F $\pm$ 5%	
C301	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C302	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C303	Mica, 27 pF $\pm$ 5% 500 V	4700-0235	88419	CM22D, 27 pF $\pm$ 5%	5910-974-5716
C304	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C305	Mica, 82 pF $\pm$ 5% 500 V	4700-0382	14655	22A, 82 pF $\pm$ 5%	
C306	Mica, 12 pF $\pm$ 5% 500 V	4700-0205	14655	22A, 12 pF $\pm$ 5%	
C307	Mica, 120 pF $\pm$ 5% 500 V	4700-0426	14655	22A, 120 pF $\pm$ 5%	
C308	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C309	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C401	Ceramic, 33 pF $\pm$ 5% 500 V (N470)	4416-0335			
C402	Mica, 0.001 μ F $\pm$ 5% 300 V	4700-1190	14655	22A3D1, 1 k pF $\pm$ 5%	
C403	0.01 μ F $\pm$ 10% 200 V	1160-0420	24655	1160-0420	
C404	Mica, 33 pF $\pm$ 5% 200 V	4700-0301	14655	22A5Q33	
C405	Mica, 220 pF $\pm$ 5% 500 V	4700-0519	14655	22A, 220 pF $\pm$ 5%	
C406	Trimmer, 5.5 to 18 pF 350 V	4910-2031	72982	538-006, 5.5 to 18 pF	
C407	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C408	Ceramic, 1.5 pF $\pm$ 10% 500 V	4400-0159	78488	GA, 1.5 pF $\pm$ 10%	
C409	Ceramic, 0.22 μ F $\pm$ 20% 25 V	4400-2052	80183	5C13, 0.22 μ F $\pm$ 20%	5910-974-5694
C410	Mica, 220 pF $\pm$ 5% 500 V	4700-0519	14655	22A, 220 pF $\pm$ 5%	
C411	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C412	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C413	Ceramic, 0.1 μ F $\pm$ 20% 25 V	4400-2050	80183	5C13, 0.1 μ F $\pm$ 20%	5910-974-5695
C414	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C415	Mica, 22 pF $\pm$ 10% 500 V	4700-0229	14655	22A5Q22, 22 pF $\pm$ 10%	

INDUCTORS

L201	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L202	Coil, air core	1160-2280	24655	1160-2280	
L203	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L204	Adjustable, ceramic	1160-2270	24655	1160-2270	
L205	Adjustable, ceramic	1160-2270	24655	1160-2270	
L206	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L207	Adjustable, ceramic	1160-2380	24655	1160-2380	
L208	Choke, rf, 1.5 μ H $\pm$ 10%	4300-1000	99800	1537, 1.5 μ H $\pm$ 10%	
L209	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L301	Adjustable, ceramic	1160-2330	24655	1160-2330	
L302	Adjustable, ceramic	1160-2340	24655	1160-2340	
L401	Choke, rf, 150 μ H $\pm$ 10%	4300-3810	99800	3500-12, 150 μ H $\pm$ 10%	5950-770-3508
L402	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L403	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
RESISTORS					
R101	Composition, 39 k Ω $\pm$ 5% 1/4 W	6099-3395	75042	BTS, 39 k Ω $\pm$ 5%	5905-686-3358
R102	Potentiometer, wire-wound 20 k Ω $\pm$ 10%	Part of 1160-2900			
R103	Composition, 39 k Ω $\pm$ 5% 1/4 W	Part of 1160-2900			
R104	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	Part of 1160-2900			
R105	Potentiometer, wire-wound 5 k Ω $\pm$ 10%	Part of 1160-2900			
R201	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R202	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R203	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R204	Composition, 82 Ω $\pm$ 5% 1/4 W	6099-0825	75042	BTS, 82 Ω $\pm$ 5%	
R205	Composition, 47 Ω $\pm$ 5% 1/4 W	Part of 1160-2271			
R206	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240
R207	Composition, 47 Ω $\pm$ 5% 1/4 W	Part of 1160-2231			
R208	Composition, 15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R209	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	Part of 1160-2231			
R210	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R211	Composition, 47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R212	Potentiometer, composition 2 k Ω $\pm$ 10%	6057-2209	80294	275-1, 2 k Ω $\pm$ 10%	
R213	Composition, 470 Ω $\pm$ 5% 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm$ 5%	5905-683-2242
R214	Composition, 820 Ω $\pm$ 5%	6099-1825	75042	BTS, 820 Ω $\pm$ 5%	
R215	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240
R216	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R217	Composition, 1.6 k Ω $\pm$ 5% 1/4 W	6099-2165	75042	BTS, 1.6 k Ω $\pm$ 5%	
R218	Composition, 15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R219	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm$ 5%	
R220	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm$ 5%	
R221	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm$ 5%	
R301	Composition, 47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R302	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R303	Composition, 22 Ω $\pm$ 5% 1/4 W	6099-0225	75042	BTS, 22 Ω $\pm$ 5%	5905-279-5459
R304	Composition, 47 Ω $\pm$ 5% 1/4 W	6099-0475	75042	BTS, 47 Ω $\pm$ 5%	
R305	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155	75042	BTS, 150 Ω $\pm$ 5%	5905-683-2243
R306	Composition, 33 Ω $\pm$ 5% 1/4 W	6099-0335	75042	BTS, 33 Ω $\pm$ 5%	
R401	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9998
R402	Composition, 33 k Ω $\pm$ 5% 1/4 W	6099-3335	75042	BTS, 33 k Ω $\pm$ 5%	
R403	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm$ 5%	
R404	Composition, 1.8 k Ω $\pm$ 5% 1/4 W	6099-2185	75042	BTS, 1.8 k Ω $\pm$ 5%	5905-688-3738
R405	Composition, 15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R406	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R407	Composition, 15 k Ω $\pm$ 5% 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm$ 5%	5905-681-8818
R408	Composition, 470 Ω $\pm$ 5% 1/4 W	6099-1475	75042	BTS, 470 Ω $\pm$ 5%	5905-683-2242
R409	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240
R410	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R411	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R412	Composition, 2.7 k Ω $\pm$ 5% 1/4 W	6099-2275	75042	BTS, 2.7 k Ω $\pm$ 5%	
R413	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R414	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R415	Composition, 27 k Ω $\pm$ 5% 1/4 W	6099-3275	75042	BTS, 27 k Ω $\pm$ 5%	5905-683-3838
TRANSFORMERS					
T201	Adjustable, ferrite cup	5000-2802	24655	5000-2802	
T202	Adjustable, ceramic	1160-2370	24655	1160-2370	
T203	Adjustable, ceramic	1160-2230	24655	1160-2230	
T204	Adjustable, ceramic	1160-2210	24655	1160-2210	
T205	Adjustable, ferrite cup	5000-2830	24655	5000-2830	
T301	Adjustable, ceramic	1160-2350	24655	1160-2350	
T401	Adjustable, ferrite cup	5000-2831	24655	5000-2831	
T402	Adjustable, ferrite cup	5000-2804	24655	5000-2804	
TRANSISTORS					
Q201	Type 2N3250	8210-1089	80211	2N3250	5961-945-4108
Q202	Type 2N3250	8210-1089	80211	2N3250	5961-945-4108
Q203	Type 2N3250	8210-1028	80211	2N3250	5961-945-4108
Q204	Type 2N708	8210-3089	24454	2N708	5961-954-6100
Q205	Type 2N708	8210-3089	24454	2N708	
Q206	Type 2N3250	8210-1028	81349	2N2218	5960-059-4464
Q207	Type 2N708	8210-3089	24454	2N708	
Q208	Type 2N3250	8210-1045	01295	2N2188	5960-065-5373
Q301	Type 2N3250	8210-1028	81349	2N2218	5960-059-4464
Q302	Type 2N3250	8210-1028	81349	2N2218	5960-059-4464
Q401	Type 2N3250	8210-1045	01295	2N2188	5960-065-5373
Q402	Type 2N3250	8210-1045	01295	2N2188	5960-065-5373
Q403	Type 2N3250	8210-1045	01295	2N2188	5960-065-5373
MISCELLANEOUS					
CR201	Diode, semiconductor, type 1N955	6082-1002	80368	1N995	
CR202	Diode, semiconductor, type 1N995	6082-1002	80368	1N995	
CR401	Diode, semiconductor, type 1N953	6084-1006	84411	1N953	
J101	JACK, Etched-circuit, Part of 1160-2900	1160-6110	24655	1160-6110	
J102	JACK, Etched-circuit, Part of 1160-2900	1160-6110	24655	1160-6110	
J401	JACK, Etched-circuit, eyelet type	1160-6110	24655	1160-6110	
J402	JACK, Etched-circuit, eyelet type	1160-6110	24655	1160-6110	
J403	JACK, Etched-circuit, eyelet type	1160-6110	24655	1160-6110	
J404	JACK, Etched-circuit, eyelet type	1160-6110	24655	1160-6110	



NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

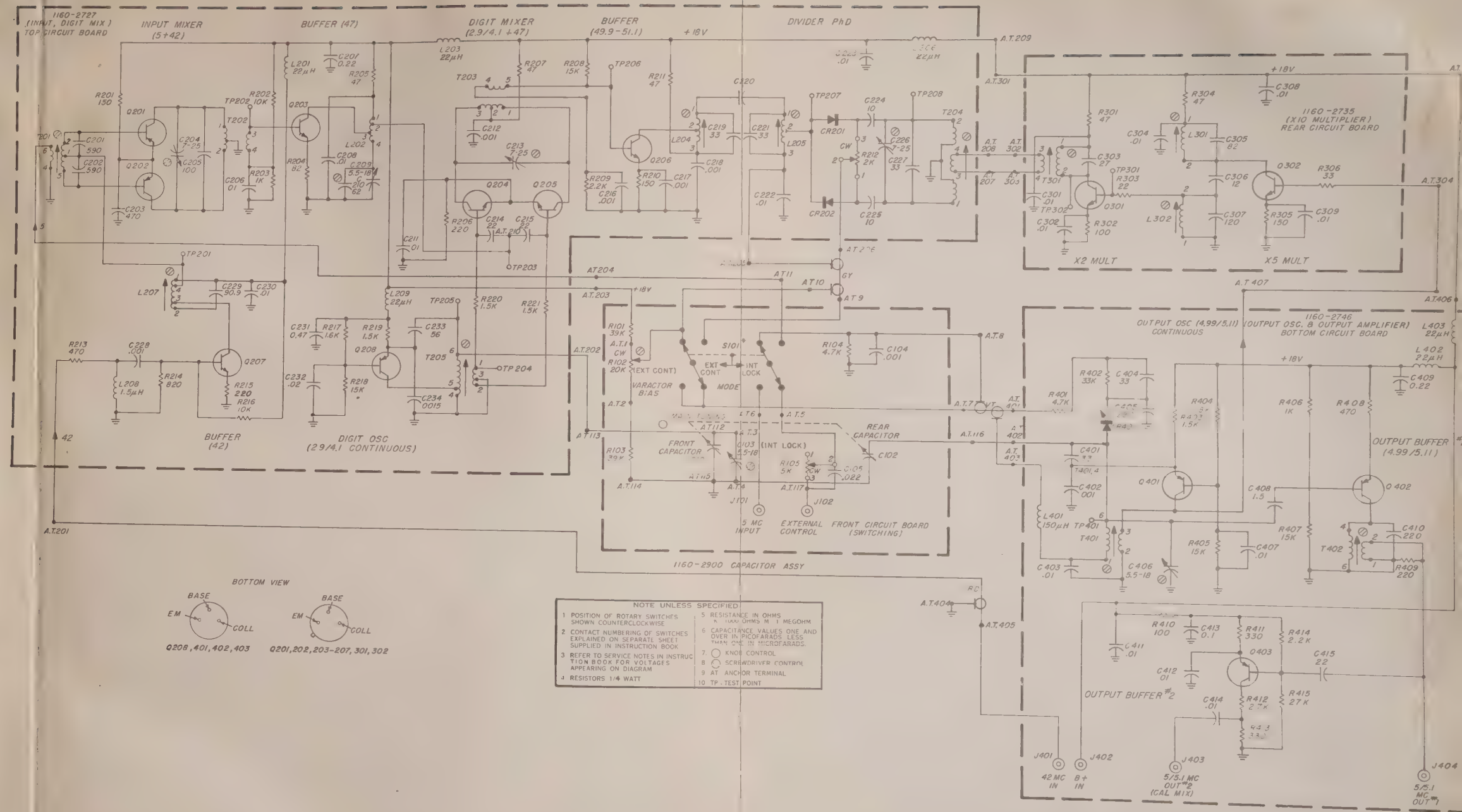
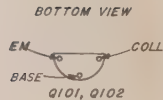


Figure EA-11.
Over-all schematic diagram for the Continuously Adjustable Decade CAD-1.
(P/N 1160-4020).



Figure EA-12.
Calibrating Mixer module etched-circuit board
(P/N 1160-2775).



NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C101	Ceramic, 1 μ F $\pm 20\%$ 25 V	4400-2070	80183	5C13, 1 μ F $\pm 20\%$	5910-083-6445
C102	Ceramic, 0.01 μ F $\pm 80-20\%$ 50 V	4401-3100	80131	CC61, 0.01 μ F $\pm 80-20\%$	5910-974-5697
C103	Ceramic, 0.1 μ F $\pm 20\%$ 25 V	4400-2050	80183	5C13, 0.1 μ F $\pm 20\%$	5910-974-5695
C104	Ceramic, 1 μ F $\pm 20\%$ 25 V	4400-2070	80183	5C13, 1 μ F $\pm 20\%$	5910-083-6445
C105	Ceramic, 100 pF $\pm 10\%$ 500 V	4404-1108	72982	831, 100 pF $\pm 10\%$	
C106	Ceramic, 100 pF $\pm 10\%$ 500 V	4404-1108	72982	831, 100 pF $\pm 10\%$	
C107	Ceramic, 0.02 μ F $\pm 80-20\%$ 50 V	4402-3200	01121	35-203, 0.02 μ F $\pm 80-20\%$	5910-952-8659
C108	Ceramic, 470 pF $\pm 10\%$ 500 V	4404-1478	72982	831, 470 pF $\pm 10\%$	
C109	Ceramic, 1 μ F $\pm 20\%$ 25 V	4400-2070	80183	5C13, 1 μ F $\pm 20\%$	5910-083-6445
C110	Mica, 27 pF $\pm 5\%$ 500 V	4700-0235	88419	CM22D, 27 pF $\pm 5\%$	5910-974-5716
C111	Ceramic, 0.0047 μ F $\pm 80-20\%$ 500 V	4405-2479	72982	801, 0.0047 μ F $\pm 80-20\%$	
RESISTORS					
R101	Composition, 8.2 k Ω $\pm 5\%$ 1/4 W	6099-2825	75042	BTS, 8.2 k Ω $\pm 5\%$	
R102	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$	5905-681-6462
R103	Composition, 100 Ω $\pm 5\%$ 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm 5\%$	
R104	Composition, 18 k Ω $\pm 5\%$ 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm 5\%$	5905-687-0000
R105	Potentiometer, composition 5 k Ω $\pm 10\%$	6057-2509	07999	992 P, 5 k Ω $\pm 10\%$	
R106	Composition, 1 k Ω $\pm 5\%$ 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm 5\%$	5905-681-6462
R107	Composition, 8.2 k Ω $\pm 5\%$ 1/4 W	6099-2825	75042	BTS, 8.2 k Ω $\pm 5\%$	
R108	Composition, 18 k Ω $\pm 5\%$ 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm 5\%$	5905-687-0000
R109	Composition, 1.2 k Ω $\pm 5\%$ 1/4 W	6099-2125	75042	BTS, 1.2 k Ω $\pm 5\%$	
R110	Composition, 3.3 k Ω $\pm 5\%$ 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm 5\%$	5905-681-9969
R111	Composition, 15 k Ω $\pm 5\%$ 1/4 W	6099-3155	75042	BTS, 15 k Ω $\pm 5\%$	5905-681-8818
MISCELLANEOUS					
CR101	Diode, semiconductor, type 1N191	6082-1008	93916	1N191	5961-296-3360
CR102	Diode, semiconductor, type 1N191	6082-1008	93916	1N191	5961-296-3360
CR103	Diode, semiconductor, type 1N191	6082-1008	93916	1N191	5961-296-3360
CR104	Diode, semiconductor, type 1N191	6082-1008	93916	1N191	5961-296-3360
L101	Inductor, choke, rf, 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$	5950-668-5867
L102	Inductor, choke, rf, 22 μ H $\pm 10\%$	4300-2600	99800	1537, 22 μ H $\pm 10\%$	5950-668-5867
L103	Inductor, choke, rf, 150 μ H $\pm 10\%$	4300-3810	99800	3500-12, 150 μ H $\pm 10\%$	5950-770-3508
L104	Inductor, Adjustable, ferrite cup	5000-2828	24655	5000-2828	
PL101	Plug, multipin, etched-circuit type	1160-2775	24655	1160-2775	
Q101	Transistor, type 2N3905	8210-1114	04713	2N3905	
Q102	Transistor, type 2N3905	8210-1114	04713	2N3905	

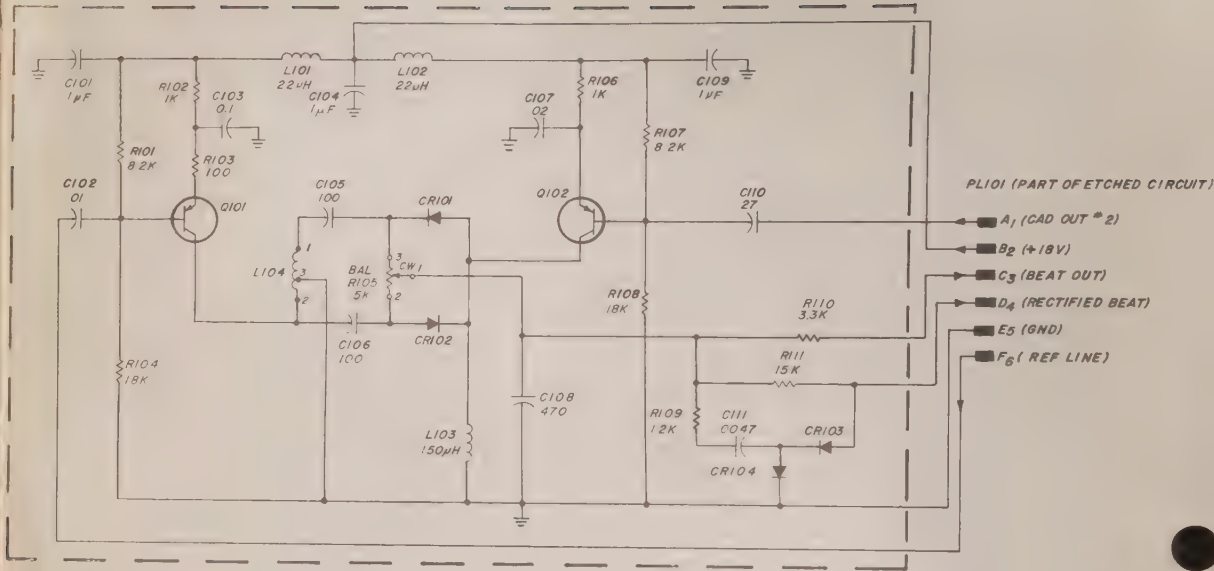


Figure EA-13.
Over-all schematic diagram for the Calibrating Mixer CM-1
(P/N 1160-4030).

NOTE UNLESS SPECIFIED

1 POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE	5 RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
2 CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK	6 CAPACITANCE VALUES ONE AND OVER IN PICO FARADS, LESS THAN ONE IN MICRO FARADS
3 REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM	7 KNOB CONTROL
4 RESISTORS 1/4 WATT	8 SCREWDRIVER CONTROL
	9 AT-ANCHOR TERMINAL
	10 TP-TEST POINT

SERVICE INSTRUCTIONS

section **FA**

OUTPUT MIXER, OM-1

P/N 1161-4000

(Used only on Type 1161 Synthesizer)

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GENERAL RADIO COMPANY

West Concord, Massachusetts



SECTION FA-1

INTRODUCTION

FA-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section has been prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension (by experienced service personnel) of the principles of operation. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate parts identification, reference designators used in the text and on the photographs are the same as those that appear on the complete schematic diagram and in the parts list.

The service instructions are written to facilitate use of a properly functioning synthesizer as a basic test frame for the module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the wide-spread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

Familiarity with the system principles of operation, as discussed in Section 4 of the front portion of this manual, is assumed as a basis for this section. Reference to other module sections should also be made as required.

FA-1.2 PURPOSE.

As noted in paragraph 4.2, the 0- to 100-kc output frequency of a Type 1161 Synthesizer is the result of a heterodyne between a frequency synthesized anywhere in the band from 5.0 to 5.1 Mc/s, and a fixed frequency of 5.0 Mc/s. It is the purpose of the OM-1 Output Mixer module to accept these frequencies from banana plugs in the sandwich deck of the Main Frame, amplify them suitably, and combine them in a balanced mixer. The mixer output, after filtering, is

supplied to the input of the main Output Amplifier, P/N 1160-4040, which is a part of the chassis P/N 1160-4060. (Refer to Section BA on the Main Frame, for interconnection circuits.)

FA-1.3 DESCRIPTION (Figure FA-1).

The Output Mixer module OM-1 plugs onto the rear of the sandwich deck of the Main Frame. Ground connection between the deck and the module case is made by a series of sheet-metal springs, fastened to the deck, that grip the bottom edges of the brass-strip rails which form the outside shell of the module. Two 4-40 screws, which mate with threaded inserts at each end of the rear surface, secure the unit in place.

Circular posts, mounted on the exterior surfaces of the end plates of the unit, serve during disassembly as prying points, by means of which the module can be raised vertically, until the grounding springs and banana plugs are disengaged.

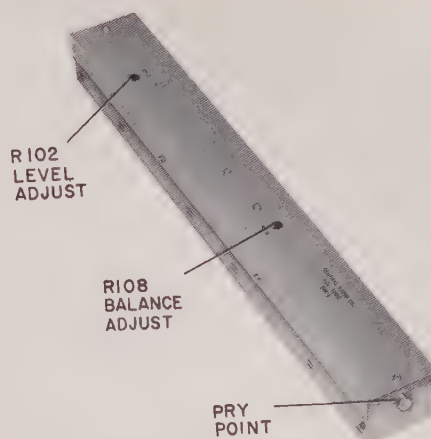


Figure FA-1. Output Mixer module - OM-1.

SECTION FA-2

PRINCIPLES OF OPERATION

FA-2.1 SIGNAL FLOW.

The electrical circuit of the unit is shown in Figure FA-4. A 5.0-Mc reference signal from the AFS crystal oscillator enters at J101A and is fed, via buffer amplifier Q102, to the push-pull side of the output mixer at L104. The 5.0 to 5.1-Mc input (from the train of Digit-Insertion units) enters at J101 and, after amplification by Q101, supplies the other mixer input. The mixer consists of CR101/CR102 and associated components.

The balance control, R108, is used to set the dc component of the output at zero volts. Accurate setting of this control is of importance primarily in connection with dc-coupled output from the synthesizer. (Refer to paragraph 3.4 in the front portion.)

The mixer output, filtered by L102, L103, and C105, C106 and C107 to remove high-frequency components, leaves the module by J202. The low side of the output (at J201) is also grounded at the far end of the coaxial cable which feeds the final Output Amplifier (via AT411 and AT412). Refer to Section BA for details on the Output Amplifier.

Only six banana plugs, in the output-mixer section of the sandwich deck, make electrical connection to the circuits (via jacks J101, J102, J101A, J102A, J201 and J202) of the OM-1 module. The two banana plugs, which conduct 50-Mc and 50/51-Mc outputs from the OMM-1 unit (section FB) when the chassis is used in a Type 1162 Synthesizer, pass through clearance holes in the etched board of this unit and are therefore not activated in a Type 1161 Synthesizer.



SECTION FA-3

SERVICE AND MAINTENANCE

FA-3.1 GENERAL.

If the system trouble-analysis procedures of Section 5 at the front of the manual indicate possible malfunction of the OM-1 unit, the most positive verification of this suspicion is the substitution of another OM-1 module. An OMM-1 module (Section FB) is an equally acceptable substitute.

Since there is but one OM-1 module per instrument, and since service spares may not be available, it will not always be possible to make the substitution. However, selected tests, and most alignment procedures can be made in the field.

FA-3.2 TEST EQUIPMENT RECOMMENDED.

Table FA-1 lists the equipment recommended for service of the module. Equivalent equipment may be substituted.

FA-3.3 REMOVAL AND DISASSEMBLY.

FA-3.3.1 REMOVAL FROM MAIN FRAME.

Removal of the module is accomplished as follows:

a. Remove the synthesizer from its case and remove the support bar across the back of the Main Frame chassis.

b. Remove the two 4-40 Phillips-head screws that attach the module to the rear wall of the chassis.

c. Insert a small screwdriver blade through the cutout in the right-hand rear corner of the synthesizer chassis side wall, under the circular post on that end of the module.

d. Insert a second screwdriver blade between the post at the opposite end and the top of the side wall.

e. Pry both ends up simultaneously, until the ground contacts and banana plugs are disconnected.

TABLE FA-1
TEST EQUIPMENT RECOMMENDED

<u>Function</u>	<u>Type Recommended</u>	<u>Minimal Characteristics</u>
Electronic Voltmeter (VTVM)	GR 1806	2% accuracy ac and dc capabilities; 1 – 55-Mc range; 0.2 V sensitivity; probe capacity 2.0 pF maximum.
Oscilloscope	Tektronix Model 543 (with C/A plug-in and P6006 10X passive probe)	20 Mc/s, 0.5 V/cm with 8 pF probe capacitance.
Distortion Analyzer	HP Model 331A	0 – 15 kc/s

FA-3.3.2 REMOVAL OF COVER.

Cover removal is accomplished as follows:

- a. Remove the four 4-40 screws in the top of the module, and the two from each side to release the cover.
- b. Lift it off and retain the cover and screws.

FA-3.3.3 REASSEMBLY.

Installation of the cover is the reverse of the above. Make sure that the cover, as it is installed, is oriented so that the adjustment-access holes are properly oriented.

FA-3.4 TROUBLE ANALYSIS.

FA-3.4.1 GENERAL (Figure FA-2 and FA-4).

Malfunction within an OM-1 module, as indicated by the system trouble-analysis procedures found in Section 5 at the front of the manual, can be isolated further here. The indications obtained from external connectors and test points on the synthesizer can be used to localize the difficulty to a particular circuit. In the procedures that follow, the top cover must be removed to permit access to interior test and adjustment points (refer to paragraph FA-3.3.2). See Figure FA-2 for locations of interior test points and adjustment controls.

In the performance of these tests the synthesizer Main Frame chassis is used to support the unit, and the other modules are used to power it and to supply loads for its outputs. All DI modules or bridging units should be in place.

With the case removed from the synthesizer and the mixer unit installed (less cover), the instrument can be operated on the test bench. The readings are the same whether or not the cover is in place.

FA-3.4.2 POWER-SUPPLY.

Measure power-supply input voltage at J102 and J102A. This voltage should be $+18 \pm 0.2$ V dc. If not, tests should be made elsewhere in the system to correct this problem (refer to Sections BA, and GC).

TABLE FA-2

DC VOLTAGE LEVELS (See Figure FA-2)

<u>Transistor</u>	<u>Emitter</u>	<u>Base</u>	<u>Collector</u>
Q101	15.0	14.7	0
Q102	1.0	1.60	17.1

NOTES:

Unit operating in chassis with all inputs; cover removed.

Measured with Type 1806-A direct.

Values are typical; variation of ± 10 are to be expected.

FA-3.4.3 SIGNAL CHECKS.

The OM-1 is not operating properly if the output at J202 (normally 0.8 V) is absent, low, or distorted, while both inputs at J101 (5/5.1 Mc/s) and J101A (5.0 Mc/s) are present, at an approximate level of 0.3 V. Set the front-panel LEVEL CONTROL fully CCW for this test.

Absence or low level of output signal may be due to failure of either amplifier, Q101 or Q102; a check of the input signals to the diodes is first indicated. Ac voltages at the mixer inputs are: (VTVM) 1.0 V at L101, terminal 2, and 7 to 8 V at L104, terminals 1 or 3. Low voltage at L101 will lower the mixer output; low voltage at L104 will distort the output signal.

Check dc voltages of the transistors, by use of a probe, on the component side of the etched-circuit board, while the unit is installed in the chassis. Appropriate values are given in Table FA-2.

FA-3.5 ALIGNMENT PROCEDURES.

FA-3.5.1 GENERAL.

If the trouble-analysis procedures of paragraph FA-3.4 indicate marginal performance of a circuit function, or if repairs or replacements have been

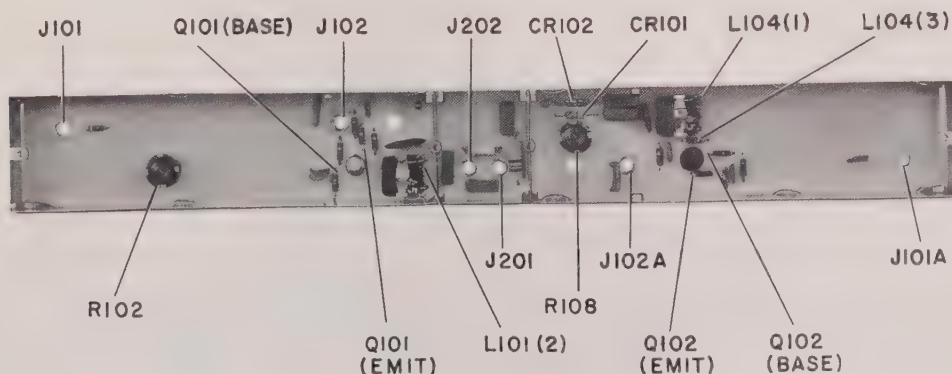


Figure FA-2. Test points and secondary-adjustment controls of Output Mixer module.



made, realignment or adjustments of circuits in the OM-1 unit may be required.

There are two factory-adjusted tuning controls (L101 and L104), a level control (R102), and a mixer-balance control (R108). Normally these should need no adjustment and should not be disturbed in ordinary circumstances. In the adjustment procedures that follow, a JFD #5284 adjustment tool (or equivalent) is recommended. Suggested inputs can conveniently be obtained by plugging the module onto an operating Type 1161 Synthesizer (with dials set for 50 kc/s and LEVEL CONTROL fully CCW).

FA-3.5.2 5.0-Mc INPUT.

With an internal 5-Mc signal of about 0.3 V, rms, applied at J101A, tune L104 for peak output voltage at terminal 1 or 3 of L104. Use the VTVM.

FA-3.5.3 5/5.1 Mc INPUT.

With an internal signal of 0.3 V, rms, to J101, at a frequency of approximately 5.05 Mc/s (selected by front-panel step-digit controls), tune L101 for peak output voltage at terminal 2 of L101, using the VTVM. This is a preliminary adjustment. If an otherwise well-aligned synthesizer is being used as a test jig, it is desirable to obtain equality between the synthesizer output at 1 kc/s and at 99 kc/s by retuning this circuit. These settings are also obtained through use of front-panel step-digit controls.

FA-3.5.4 GAIN.

With L101 and L104 properly tuned, and with signals as specified above applied to J101 and J101A, adjust R102 for 0.8 V, rms, at J202. J202 should be

loaded by normal synthesizer circuitry, or by 10 kilohms.

FA-3.5.5 BALANCE.

With alignment complete, and signals applied as specified above, adjust R108 for 0 volt dc at J202.

FA-3.5.6 DISTORTION.

To obtain lowest distortion of the output signal, connect a distortion analyzer to the synthesizer output. Set the synthesizer frequency to 1 kc/s at 1-V output (no 50-ohm load required). Adjust L104 for minimum distortion indication.

NOTE

The cover has no influence on any part of the above alignment procedure.

FA-3.6 REPAIRS AND REPLACEMENTS.

If subnormal circuits don't respond to adjustments indicated in the alignment procedures, use the schematic diagram, Figure FA-4, to localize the trouble area; replace defective detail parts. The parts list gives pertinent descriptive information on parts used and reference designators appearing there are the same as those used on schematics and photos. The composite view of the etched-circuit board presented in Figure FA-3 shows the location of all detail parts in the module.

Basing diagrams for the transistor types used are given on the schematic diagrams. The collector lead is identified by a dot on the foil side of the etched-circuit boards.

ELECTRICAL PARTS LIST

Ref. No.	Description	GR Part No.	Mfg. Part No.	Fed. Mfg. No.	Fed. Stock Code
CAPACITORS					
C101	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C102	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C103	Ceramic, 82 pF $\pm$ 5% 500 V (N150)	4413-0825	80131	CC62, 82 pF $\pm$ 5%	5910-974-5697
C104	Ceramic, 0.47 μ F $\pm$ 20% 25 V	4400-2054	80183	5C13, 0.47 μ F	5910-974-5696
C105	Mica, 150 pF $\pm$ 10% 500 V	4700-0440	14655	22AST15, 150 pF $\pm$ 10%	
C106	Mica, 270 pF $\pm$ 10% 500 V	4700-0527	14655	22A, 270 pF $\pm$ 10%	
C107	Mica, 330 pF $\pm$ 5% 500 V	4700-0516	14655	22A, 330 pF $\pm$ 5%	
C108	Mica, 56 pF $\pm$ 10% 500 V	4700-0316	14655	22A, 56 pF $\pm$ 10%	
C109	Mica, 56 pF $\pm$ 10% 500 V	4700-0316	14655	22A, 56 pF $\pm$ 10%	
C110	Ceramic, 82 pF $\pm$ 5% 500 V (N150)	4413-0825	80131	CC62, 82 pF $\pm$ 5%	
C111	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C112	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C113	Ceramic, 0.47 μ F $\pm$ 20% 25 V	4400-2054	80183	5C13, 0.47 μ F $\pm$ 20%	5910-974-5696
C114	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
RESISTORS					
R101	Composition, 390 Ω $\pm$ 5% 1/4 W	6099-1395	75042	BTS, 390 Ω $\pm$ 5%	
R102	Potentiometer, composition, 500 Ω $\pm$ 20%	6040-0300	01121	FWC, 500 Ω $\pm$ 20%	5905-072-7795
R103	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R104	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	75042	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R105	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R106	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R107	Composition, 8.2 k Ω $\pm$ 5% 1/4 W	6099-2825	75042	BTS, 8.2 k Ω $\pm$ 5%	
R108	Potentiometer, composition, 5 k Ω $\pm$ 20%	6040-0600	01121	FWC, 5 k Ω $\pm$ 20%	5905-034-5374
R109	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	01121	BTS, 100 Ω $\pm$ 5%	
R110	Composition, 10 Ω $\pm$ 5% 1/4 W	6099-0105	01121	BTS, 10 Ω $\pm$ 5%	5905-809-8596
R111	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	01121	BTS, 100 Ω $\pm$ 5%	
R112	Composition, 22 Ω $\pm$ 5% 1/4 W	6099-0225	01121	BTS, 22 Ω $\pm$ 5%	5905-279-5459
R113	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105	01121	BTS, 10 k Ω $\pm$ 5%	5905-683-2238
R114	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	01121	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
MISCELLANEOUS					
	Assembly, etched-circuit board	1160-2701	24655	1160-2701	
CR101	Diode, semiconductor, type 1N35 (S)	6082-1004	58854	1N35(S)	
CR102	Diode, semiconductor, type 1N35(S)	6082-1004	58854	1N35(S)	
L101	Inductor, ferrite cup, adjustable	5000-2850	24655	5000-2850	
L102	Inductor, choke iron core, 150 μ H $\pm$ 10%	4300-3810	99800	3500-12, 150 μ H $\pm$ 10%	5950-770-3508
L103	Inductor, choke iron core, 8200 μ H $\pm$ 10%	4300-6391	72259	Wee-Ductor, 8200 μ H $\pm$ 10%	
L104	Inductor, ferrite cup, adjustable	5000-2850	24655	5000-2850	
J101	Jack, etched-circuit type	1160-6110	24655	1160-6110	
J101A	Jack, etched-circuit type	1160-6110	24655	1160-6110	
J102	Jack, etched-circuit type	1160-6110	24655	1160-6110	
J102A	Jack, etched-circuit type	1160-6110	24655	1160-6110	
J201	Jack, etched-circuit type	1160-6110	24655	1160-6110	
J202	Jack, etched-circuit type	1160-6110	24655	1160-6110	
Q101	Transistor, type 2N2188	8210-1045	01295	2N2188	5960-065-5373
Q102	Transistor, type 2N2218	8210-1028	81349	2N2218	5960-059-4464

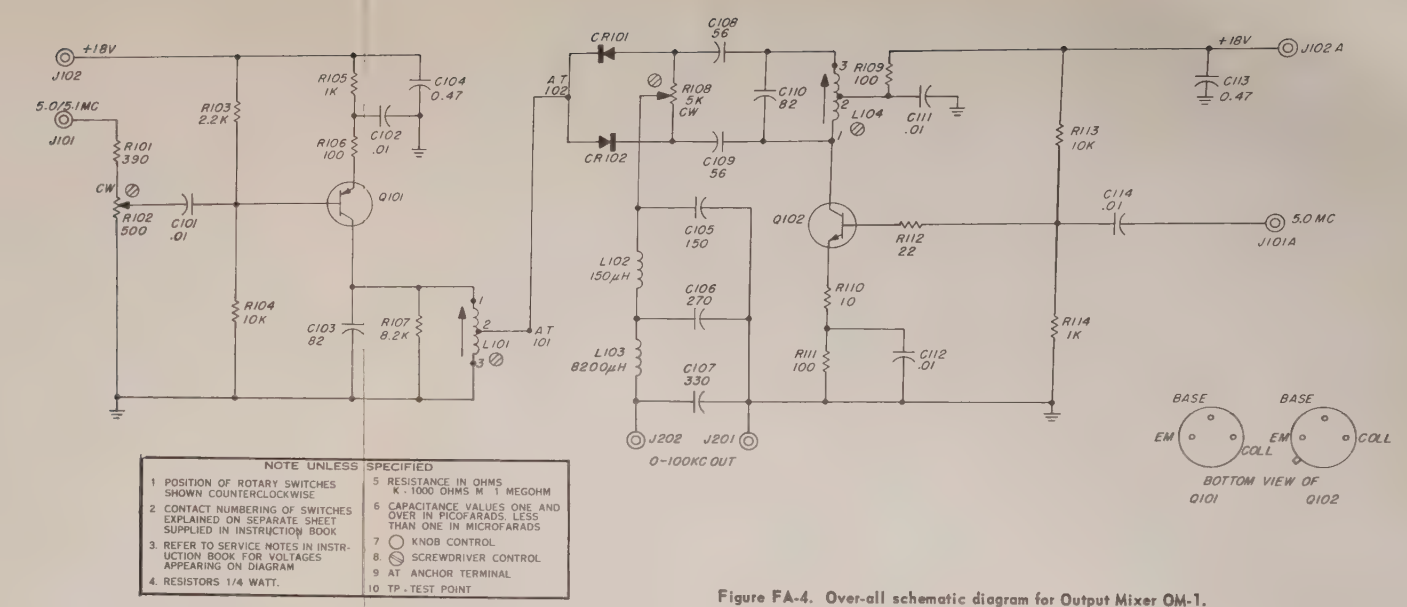


Figure FA-4. Over-all schematic diagram for Output Mixer OM-1.

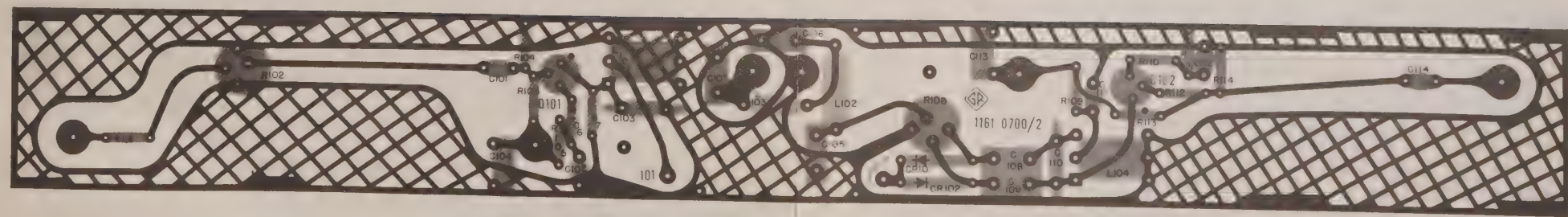


Figure FA-3. Etched circuit board of Output Mixer OM-1 (P/N 1160-2701). Composite view. Number on foil side is not the complete assembly part number.

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

SERVICE INSTRUCTIONS

section **FB**

OUTPUT MULTIPLIER MIXER _ OMM-1

P/N 1162-4000

(Used only in Type 1162 Synthesizers)

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GENERAL RADIO COMPANY

West Concord, Massachusetts

SECTION FB-1

INTRODUCTION

FB-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section has been prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension (by experienced service personnel) of the principles of operation. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate parts identification, reference designators used in the text and on the photographs are the same as those that appear on the complete schematic diagram and in the parts list.

The service instructions are written to facilitate use of a properly functioning synthesizer as a basic test frame for the module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the widespread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

Familiarity with the system principles of operation, as discussed in Section 4 of the front portion of this manual, is assumed as a basis for this section. Reference to other module sections should also be made as required.

FB-1.2 PURPOSE.

As noted in paragraph 4.2, the 0- to 1-Mc output frequency of a Type 1162 Synthesizer is the result of a heterodyne between a frequency synthesized anywhere in the band from 5.0 to 5.1 Mc/s, and a fixed frequency of 5.0 Mc/s, both after X10 multiplication. It is the purpose of the OMM-1 Output Mixer module to accept these initial frequencies from banana plugs in the sandwich deck of the Main Frame, amplify them suitably, multiply them, and combine them in a balanced mixer.



Both the 5.0- to 5.1-Mc output from the train of DI units, and the 5.0-Mc signal from the AFS crystal oscillator, are processed in separate X10 multiplier circuits in the OMM-1, to arrive at mixer frequencies of 50 to 51 Mc/s and 50 Mc/s. The mixer output, after filtering, is supplied to the input of the main Output Amplifier, P/N 1160-4040, which is a part of the chassis P/N 1160-4060. (Refer to Section BA on the Main Frame, for interconnection circuits.)

FB-1.3 DESCRIPTION (Figure FB-1).

The Output Mixer module OMM-1 plugs onto the rear of the sandwich deck of the Main Frame. Ground connection between the deck and the module case is made by a series of sheet-metal springs, fastened to the deck, that grip the bottom edges of the brass-strip rails which form the outside shell of the module. Two 4-40 screws, which mate with threaded inserts at each end of the rear surface, secure the unit in place.

Circular posts, mounted on the exterior surfaces of the end plates of the unit, serve during disassembly as pry points, by means of which the module can be raised vertically, until the grounding springs and banana plugs are disengaged.

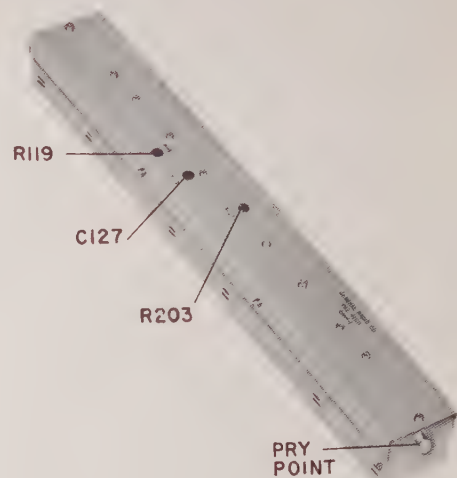


Figure FB-1.
Output Mixer module OMM-1. Note the externally accessible secondary adjustment controls.

SECTION FB-2

PRINCIPLES OF OPERATION

FB-2.1 SIGNAL FLOW.

The OMM-1 contains two essentially identical multiplier boards, one for the 5- to 5.1-Mc variable-frequency input from the train of DI units, and the other for the 5.0-Mc fixed-frequency signal. The frequency-multiplied outputs of these two circuit boards are combined in the output mixer, which occupies the central section of the assembly. The electrical circuitry of these units is shown in Figures FB-2 and FB-6.

An adjustable signal, in the band from 5 to 5.1 Mc/s, enters at J101. It drives Q101, a buffer broadly tuned at 5.05 Mc/s by L101 and C106, which drives a X5 multiplier, Q102. There are three circuits tuned to 25.0/25.5 Mc/s (the coupled pair, L102/L103, and single-tuned L104, at the collector of Q103). Q104 is a doubler, with a double-tuned 50/51-Mc circuit (L106 and L107) that couples it to the double-tuned output amplifier, Q105.

The fixed-frequency signal at 5.0 Mc/s enters the opposite end of the module, at J101A, and is multiplied and amplified in identical circuits. The only difference between the two multiplier boards is in the coupling between the last stages and in the tuning of the tuned circuits.

In the variable-frequency section, T101 is very lightly loaded on its one-turn secondary and consequently needs very small coupling to L109 for proper band-pass characteristics. Since there is some magnetic coupling between the coils, C124 is in a bucking connection to reduce the total coupling.

On the fixed-frequency multiplier board, T101A is heavily loaded by the mixer and consequently requires that C124A be connected in an aiding sense, to develop the desired critical-coupling condition.

The Output Mixer Section, comprised of CR201/CR202 and associated components, feeds the 0-1-Mc output signal through filter inductors L201 and L202 to the output jack, J202. The capacitance of the external coaxial cable, which conducts the output signal of this module to the input of the final Output Amplifier (at the front of the chassis) makes up the balance of this low-pass filter. L202 also furnishes a small amount of high-end peaking to maintain flatness of output.

FB-2.2 INPUTS AND OUTPUTS.

The low side of the output (at J201) is also grounded at the far end of the coaxial cable, which feeds the

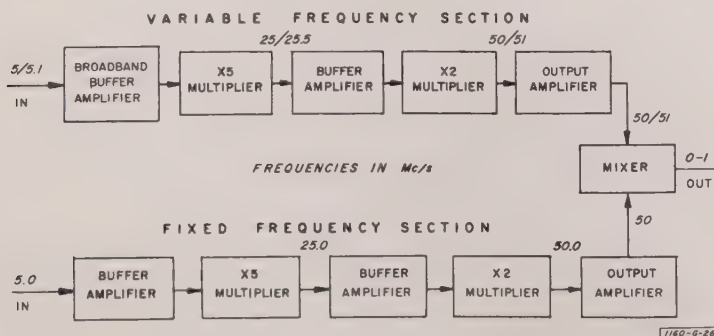


Figure FB-2.
Block diagram of OMM-1
Output Mixer.



final Output Amplifier (via AT411 and AT412). Refer to Section BA for details on the Output Amplifier.

Eight banana plugs, in the output-mixer station of the sandwich deck, make electrical connection to the circuits (via jacks J101, J101A, J102, J102A, J103, J103A, J201, and J202).

Jacks J103 and J103A connect with banana plugs in the sandwich deck which are wired, through isolating resistors, to subminiature jacks at the rear edge of the deck, to make available 50/51 Mc/s and 50 Mc/s, respectively, at low power levels.

FB-2.3 CONTROLS.

The over-all gain of each multiplier strip can be adjusted by R119 (or R119A), a screwdriver-adjustment

potentiometer, which controls the bias on the base of the output stage, Q105 (or Q105A).

Other secondary controls are the screwdriver-adjustable trimmer capacitors, C127 and C127A, placed in the output tank circuits of both multiplier strips. They are useful for touch-up adjustments of the outputs into the mixer circuit.

The balance control, R203, is used to set the dc component of the mixed outputs at zero volts. Accurate setting of this control is of importance primarily in connection with dc-coupled output from the synthesizer. (Refer to paragraph 3.4 in the front portion.)

The frequency alignment of this module is slightly sensitive to the presence of the top cover. As a result, final touch-up adjustments must be made with the cover in place and the unit mounted on the Main Frame.

SECTION FB-3

SERVICE AND MAINTENANCE

FB-3.1 GENERAL.

If the system trouble-analysis procedures of Section 5 at the front of the manual indicate possible malfunction of the OMM-1 unit, the most positive verification of this suspicion is the substitution of another OMM-1 module. An OM-1 module (Section FA) is an acceptable substitute, with the top-frequency limit of 100 kc/s.

Since there is but one OMM-1 module per instrument and since service spares may not be available, it will not always be possible to make the substitution. However, selected tests and alignment procedures can be made in the field.

FB-3.2 TEST EQUIPMENT.

Table FB-1 lists the equipment recommended for service of the module; equivalent equipment may be substituted.

FB-3.3 REMOVAL AND DISASSEMBLY.

FB-3.3.1 REMOVAL FROM MAIN FRAME.

Removal of the module is accomplished as follows:

CAUTION

Turn power off before removal of module.

a. Remove the synthesizer from its case and remove the support bar across the back of the Main Frame chassis.

b. Remove the two 4-40 Phillips-head screws that attach the module to the rear wall of the chassis.

c. Insert a small screwdriver blade through the cutout in the right-hand rear corner of the synthesizer-chassis side wall, under the circular post on the CAD end of the module.

d. Insert a second screwdriver blade between the post at the opposite end and the top of the sidewall.

e. Pry both ends up simultaneously, until the ground contacts and banana plugs are disconnected.

FB-3.3.2 REMOVAL OF COVER.

Cover removal is accomplished as follows:

a. Dismount the module from the synthesizer chassis (paragraph FB-3.3.1).

b. Remove the ten 4-40 screws in the top of the module and the two from each side to release the cover.

c. Lift the cover off and retain it and the screws.

FB-3.3.3 REASSEMBLY.

Installation of the cover is the reverse of the above. Make sure that the cover, as it is installed, is oriented so that the adjustment-access holes are over the end away from the CAD side of the unit. Press down firmly to ensure good ground connection.

FB-3.4 TROUBLE ANALYSIS.

FB-3.4.1 GENERAL (Figure FB-3 and FB-6).

Malfunction within an OMM-1 module, as indicated by the system trouble-analysis procedures found in Section 5 at the front of the manual, can be isolated further here. The indications obtained from external

TABLE FB-1

TEST EQUIPMENT RECOMMENDED

<u>Function</u>	<u>Type Recommended</u>	<u>Minimal Characteristics</u>
Electronic Voltmeter (VTVM)	GR 1806-A	2% accuracy; ac and dc capabilities; 1 – 55-Mc range; 0.2 V sensitivity; probe capacity 2.0 pF maximum.
Termination	GR874-W50BL	Standard coaxial, 50 ohms.
Oscilloscope	Tektronix Model 543 (with C/A plug-in and P6006 10x passive probe)	20 Mc/s, 0.5 V/cm with 8 pF probe capacitance.
Distortion Analyzer	HP Model 331A	0 – 15 kc/s

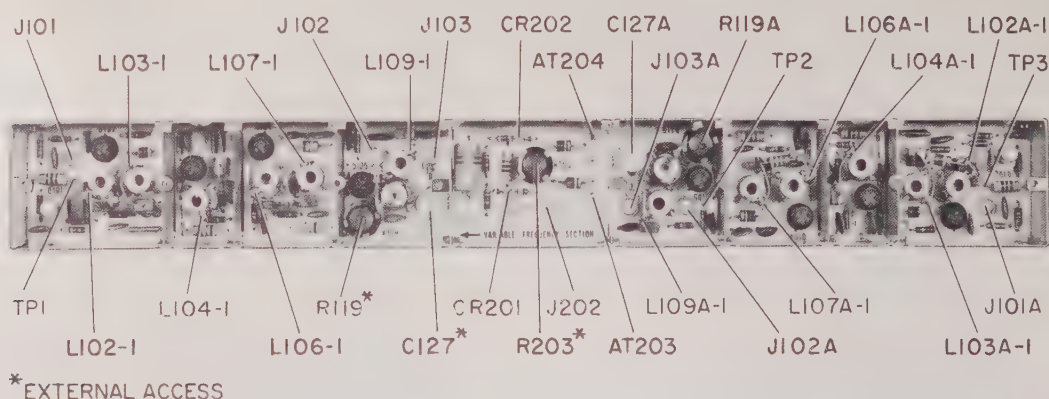


Figure FB-3. Test points and secondary adjustment controls.

connectors and test points on the synthesizer can be used to localize the difficulty to a particular circuit. In the procedures that follow, the top cover must be removed to permit access to interior test and adjustment points (refer to paragraph FB-3.3.2). See Figure FB-3 for locations of interior test points and adjustment controls.

In the performance of these tests, the synthesizer Main Frame chassis is used to support the unit, and the other modules are used to power it and to supply loads for its outputs. All DI modules or bridging units should be in place.

With the case removed from the synthesizer and the mixer unit installed (less cover), the instrument can be operated on the test bench.

FB-3.4.2 POWER-SUPPLY.

Measure power-supply input voltage at J102 and J102A. This voltage should be $+18 \pm 0.2$ Vdc. If not, tests should be made elsewhere in the system to correct this problem (refer to Sections BA and GC).

FB-3.4.3 SIGNAL CHECKS.

The OMM-1 is not operating properly if the output at J202 (normally 0.8 V) is absent, low, or distorted, while both inputs at J101 (5/5.1 Mc/s) and J101A (5.0 Mc/s) are present, at an approximate level of 0.3 V, rms. Set the front-panel OUTPUT LEVEL control fully CCW for this test.

Absence or low level of output signal may be due to failure of either multiplier section; a check of the input signals to diodes CR201/CR202 is first indicated. Levels are given in Table FB-2. Low voltage at J103 will lower the mixer output; low voltage at AT203 or AT204 will distort the output signal.

If no indication can be obtained at either J103 or AT203 and AT204, proceed sequentially with the probe down the capacitively coupled tuned circuits, from the center toward the input buffers. The test point is always terminal 1 of L109 through L102. The stage immediately following the last tank circuit at which rf can be found, is very likely defective.

Check dc voltages of the transistors, by use of a probe, on the component side of the etched-circuit

board, while the unit is installed in the chassis. Appropriate values are given in Table FB-3.

FB-3.5 ALIGNMENT PROCEDURES.

FB-3.5.1 GENERAL (Figure FB-3).

If the trouble-analysis procedures of paragraph FB-3.4 indicate marginal performance of a circuit function, or if repairs or replacements have been made,

TABLE FB-2
TROUBLE ANALYSIS

Step	Circuit	Test Point	Level (V, rms)
1	Mixer	J103	1.7 - 2.0
2		AT203	9.0 - 11.0
3		AT204	9.0 - 11.0
4	Variable Frequency Section	L107-1	4.0
5		L104-1	4.0
6		L103-1	2.3
7		TP1 (L101)	1.9
8	Fixed Frequency Section	L107A-1	4.5
9		L104A-1	5.0
10		L103A-1	2.0
11		TP3 (L101A)	1.8

NOTES:

Type 1806-A with ac probe used for all measurements. Reference levels only, subject to fairly wide variations; R119 and R119A permit adjustment of mixer. Determination of the presence or absence of signals rather than their amplitudes will permit localization of trouble.

TABLE FB-3
DC VOLTAGES – OMM-1

<u>Transistor</u>	<u>Emitter</u>	<u>Base</u>	<u>Collector</u>	<u>Transistor</u>	<u>Emitter</u>	<u>Base</u>	<u>Collector</u>
Q101	16.4	15.9	0	Q101A	16.4	15.9	0
Q102	1.8	0	16.0	Q102A	1.4	0	16.2
Q103	2.4	3.0	17.0	Q103A	2.4	3.0	16.8
Q104	1.6	1.0	17.0	Q104A	2.0	1.0	16.8
Q105	1.4	1.0	17.0	Q105A	4.0	4.2	15.4

NOTES:

Unit operating with all inputs, installed in chassis, no cover.

Voltages measured with Type 1806-A dc + position.

These are typical readings and they are dependent on rf levels; variations of $\pm 15\%$ are to be expected.

Q105 and Q105A readings are also dependent on R119 and R119A settings.

realignment or adjustments of circuits in the OMM-1 unit may be required.

NOTE

A complete alignment, particularly of the variable-frequency section, is not possible without a sweep-generator setup and a special cover.

If frequency-insensitive components have been replaced, only a touchup may be required. Repairs in the variable-frequency section will affect the instrument output-frequency response and the output level; repairs in the fixed-frequency section will affect the output-frequency distortion.

FB-3.5.2 VARIABLE-FREQUENCY SECTION.

A JFD No. 5284 adjustment tool is recommended.* Use an operative synthesizer chassis as the test fixture and proceed as follows:

- Install the OMM-1 unit (with cover) on the deck and apply power.
- Terminate the synthesizer OUTPUT jack with 50 ohms and set the OUTPUT LEVEL control fully CW.
- Set the synthesizer output frequency to 190 kc/s and adjust R119 until the MONITOR meter (set to OUTPUT VOLTS) reads full scale, or 2.0 V.
- Adjust the OUTPUT LEVEL control for a meter reading of one division below full scale.
- Rotate the 100-kc dial (first) through all positions. If meter readings remain within ± 1 division, the output response is within specifications.
- If not, note the initial position and very carefully adjust C127 to improve response.

When response is satisfactory, readjustment of R119 (for 2.0 V into 50 ohms at lowest point of response) may be indicated.

FB-3.5.3 FIXED-FREQUENCY SECTION.

To permit this operation the OMM-1 unit has to be mounted in an operating synthesizer chassis without its cover. Use Cambion No. 2230 and JFD No. 5284 alignment tools.** The procedure is as follows:

a. Connect the VTVM (with ac probe) to L104A-1 and peak L102A, L103A.

b. Connect the VTVM to L107A-1 and peak L104A.

c. Connect the VTVM to AT204 and peak L106A, L107A, L109A and C127A. A level of 10 V, rms, should be obtained at this point; readjust R119A if necessary.

d. Measure Q105A emitter voltage at R121A (TP2); it should not exceed 4.0 V.

e. Connect the VTVM to J103A and peak C127A.

If it is desired to check distortion performance, proceed as follows:

- Set the synthesizer to 1 kc/s; OUTPUT LEVEL to 1 V approximately.
- Connect (without a 50-ohm load) the Distortion Analyzer to the OUTPUT jack.
- Use the "100 k Ω , UNBAL" mode to measure distortion.
- Adjust L106A, L107A, L109 and C127A to minimize distortion.

FB-3.5.4 MIXER-BALANCE ADJUSTMENT.

This balance, primarily provided for zero output in the synthesizer DC OUTPUT COUPLING position, may be adjusted to zero with R203 after the instrument has been set to dc output coupling and the VTVM (dc) has been connected to the output.

FB-3.6 REPAIRS AND REPLACEMENTS.

If subnormal circuits don't respond to adjustments indicated in the alignment procedures, use the schematic diagram, Figure FB-6, to localize the trouble area; replace defective detail parts. The parts list gives pertinent descriptive information on parts used and reference designators appearing there are the same as those used on schematics and photos. The composite view of the etched-circuit boards, presented in Figures FB-4 and FB-5, show the locations of all detail parts in the module. These figures can also be used to find top-of-board contacts with transistor leads.

Basing diagrams for the transistor types used are given on the schematic diagrams. The collector lead is identified by a dot on the foil side of the etched-circuit boards.

*NOTE: JFD Electronics Corporation, Brooklyn, New York.

**NOTE: Cambion Coil-Alignment Tool No 2230-1, Cambridge Thermionic Corporation, Cambridge, Massachusetts.

ELECTRICAL PARTS LIST

NOTE

Parts with the suffix A on 100-series reference designators are found in the Fixed Frequency X10 Multiplier. Others are in the Variable Frequency X10 Multiplier. Those in 200-series are on the Output Mixer board.

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C101, 101A	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C102, 102A	Ceramic, 0.47 μ F $\pm$ 20% 25 V	4400-2054	80183	5C13, 0.47 μ F $\pm$ 20%	5910-974-5696
C103, 103A	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C104, 104A	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C105, 105A	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	72136	CM15, 200 pF $\pm$ 5%	
C106, 106A	Mica, 75 pF $\pm$ 5% 500 V	4700-0375	14655	22A, 75 pF $\pm$ 5%	
C107, 107A	Ceramic, 1.5 pF $\pm$ 5% 500 V	4400-0150	78488	GA, 1.5 pF $\pm$ 5%	
C108, 108A	Ceramic, 0.01 pF +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C109, 109A	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	72136	CM15, 200 pF $\pm$ 5%	
C110, 110A	Ceramic, 10 pF $\pm$ 10% 500 V	4400-1100	78488	GA, 10 pF $\pm$ 10%	5910-668-5861
C111, 111A	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C112, 112A	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	72136	CM15, 200 pF $\pm$ 5%	
C113, 113A	Ceramic, 16 pF $\pm$ 5% 500 V (NPO)	4410-0165	72982	801, 16 pF $\pm$ 5% 500 V	
C114, 114A	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C115, 115A	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C116, 116A	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	72136	CM15D510J	
C117, 117A	Ceramic, 0.01 μ F +80-20%	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C118, 118A	Ceramic, 0.33 pF $\pm$ 5% 500 V	4400-0033	78488	GA, 0.33 pF $\pm$ 5%	5910-253-8093
C119, 119A	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C120, 120A	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	72136	CM15D510J	
C121, 121A	Ceramic, 6.8 pF $\pm$ 10% 500 V	4400-0800	78488	GA, 6.8 pF $\pm$ 10%	5910-617-9349
C122, 122A	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C123, 123A	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	72136	CM15D510J	
C124	Ceramic, 1.0 pF $\pm$ 5% 500 V	4400-0101	78488	GA, 1.0 pF $\pm$ 5%	5910-280-5936
C124A	Ceramic, 1.5 pF $\pm$ 5% 500 V	4400-0150	78488	GA, 1.5 pF $\pm$ 5%	
C125, 125A	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C126, 126A	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C127, 127A	Trimmer, 5.5-18 pF 350 V	4910-2044	72982	538-002, 5.5 to 18 pF	
C128, 128A	Ceramic, 10 pF $\pm$ 5% 500 V (N30)	4411-0105	56289	40C417	
C201	Ceramic, 5.6 pF $\pm$ 10% 500 V	4400-0569	78488	GA, 5.6 pF $\pm$ 10%	5910-931-0528
C202	Ceramic, 5.6 pF $\pm$ 10% 500 V	4400-0569	78488	GA, 5.6 pF $\pm$ 10%	5910-931-0528
INDUCTORS					
L101, 101A	Choke, rf, 10 μ H $\pm$ 10%	4300-2200	99800	1537, 10 μ H $\pm$ 10%	
L102, 102A	Adjustable	1160-2400	24655	1160-2400	
L103, 103A	Adjustable, ceramic	1160-2410	24655	1160-2410	
L104, 104A	Adjustable, ceramic	1160-2400	24655	1160-2400	
L105, 105A	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L106, 106A	Adjustable, ceramic	1160-2400	24655	1160-2400	
L107, 107A	Adjustable, ceramic	1160-2410	24655	1160-2410	
L108, 108A	Choke, rf, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L109, 109A	Adjustable, ceramic	1160-2400	24655	1160-2400	
L201	Choke, rf, 10 μ H $\pm$ 10%	4300-2200	99800	1537, 10 μ H $\pm$ 10%	
L202	Choke, rf, 560 μ H $\pm$ 10%	4300-4900	99800	3500, 560 μ H $\pm$ 10%	
RESISTORS					
R101, 101A	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R102, 102A	Composition, 18 k Ω $\pm$ 5% 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm$ 5%	5905-687-0000
R103, 103A	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R104, 104A	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240
R105, 105A	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R106, 106A	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R107, 107A	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R108, 108A	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9998
R109, 109A	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9998
R110, 110A	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105	75042	BTS, 1 k Ω $\pm$ 5%	5905-681-6462
R111, 111A	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R112, 112A	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240
R113, 113A	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335	75042	BTS, 3.3 k Ω $\pm$ 5%	5905-681-9969
R114, 114A	Composition, 22 k Ω $\pm$ 5% 1/4 W	6099-3225	75042	BTS, 22 k Ω $\pm$ 5%	5905-687-0002
R115, 115A	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	75042	BTS, 1.5 k Ω $\pm$ 5%	
R116, 116A	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R117, 117A	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1115	75042	BTS, 150 Ω $\pm$ 5%	
R118, 118A	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475	75042	BTS, 4.7 k Ω $\pm$ 5%	5905-686-9998
R119, 119A	Potentiometer, composition 2.5 k Ω 20%	6040-0500	01121	FWC, 2.5 k Ω $\pm$ 20%	
R120, 120A	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105	75042	BTS, 100 Ω $\pm$ 5%	
R121, 121A	Composition, 180 Ω $\pm$ 5% 1/4 W	6099-1185	75042	BTS, 180 Ω $\pm$ 5%	5905-279-5476
R201	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R202	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R203	Potentiometer, composition 5 k Ω 20%	6040-0600	01121	FWC, 5 k Ω $\pm$ 20%	5905-034-5374

ELECTRICAL PARTS LIST (cont)

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CIRCUIT-BOARD-ASSEMBLIES					
---	Output Mixer Circuit etched-board	1160-2705	24655	1160-2705	
---	X10 Multiplier Circuit etched-board (Variable Frequency)	1160-2716	24655	1160-2716	
---	X10 Multiplier Circuit etched-board (Fixed Frequency)	1160-2717	24655	1160-2717	
MISCELLANEOUS					
CR201, 202	Diode, type 1N35(S)	6082-1004	58854	1N35(S)	
J101, 101A	Jack, etched-circuit connector	1160-6110	24655	1160-6110	
J102, 102A	Jack, etched-circuit connector	1160-6110	24655	1160-6110	
J103, 103A	Jack, etched-circuit connector	1160-6110	24655	1160-6110	
J201	Jack, etched-circuit connector	1160-6110	24655	1160-6110	
J202	Jack, etched-circuit connector	1160-6110	24655	1160-6110	
T101, 101A	Transformer, adjustable	1160-2390	24655	1160-2390	
Q101, 101A	Transistor, type 2N3250	8210-1089	80211	2N3250	5961-945-4108
Q102, 102A	Transistor, type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q103, 103A	Transistor, type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q104, 104A	Transistor, type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q105, 105A	Transistor, type 2N2218	8210-1028	81349	2N2218	5960-059-4464

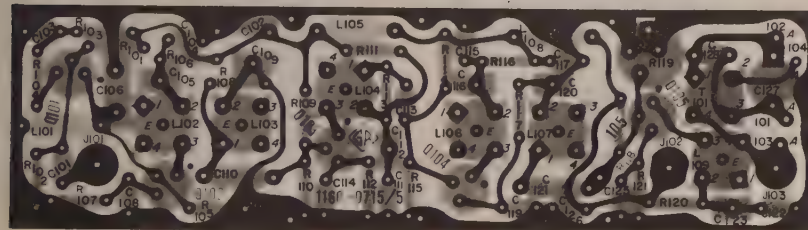


Figure FB-4. X10 Multiplier-circuit etched-board assembly (P/N 1160-2716 or 1160-2717). Boards identical except for value of C124.

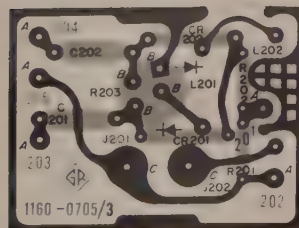
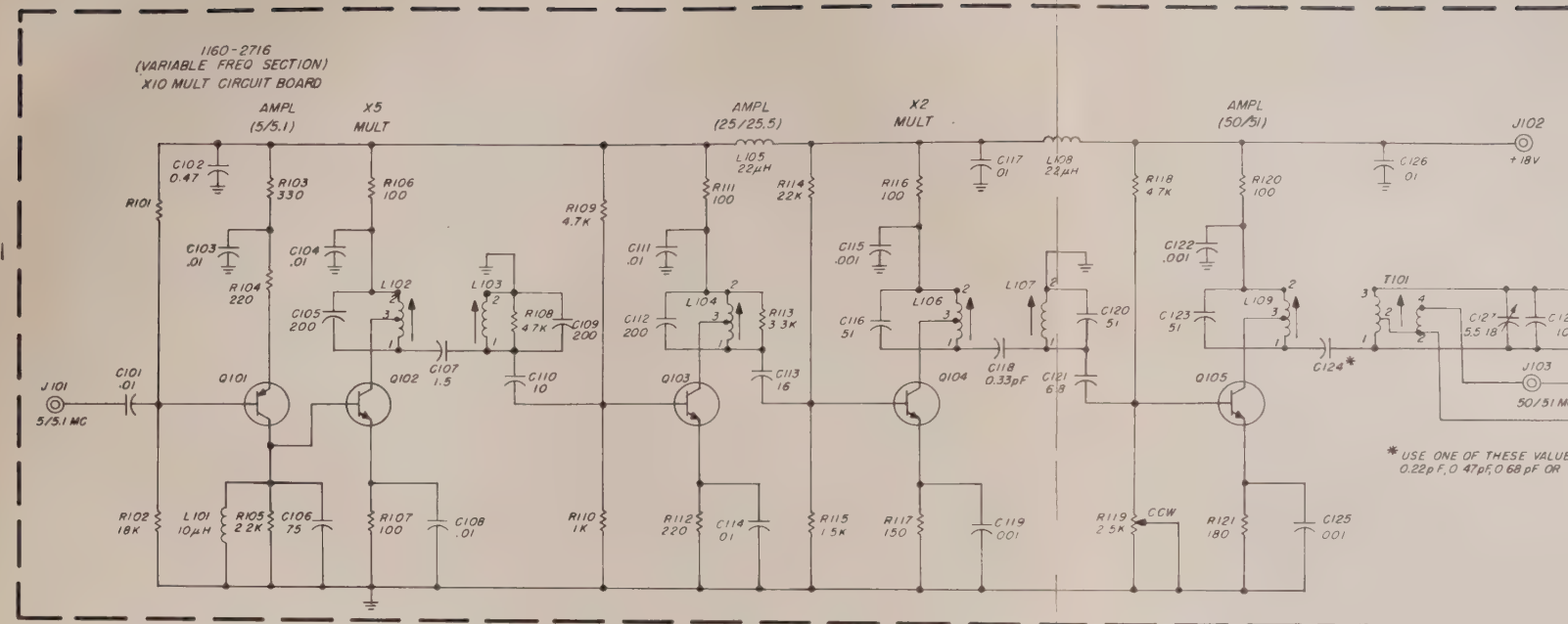


Figure FB-5. Output mixer-circuit etched-board assembly (P/N 1160-2705).

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.



- NOTE UNLESS SPECIFIED
- 1 POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE
 - 2 CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK
 - 3 REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM
 - 4 RESISTORS 1/4 WATT
 - 5 RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
 - 6 CAPACITANCE VALUES ONE AND OVER IN PICOFARADS LESS THAN ONE IN MICROFARADS
 - 7 KNOB CONTROL
 - 8 SCREWDRIVER CONTROL
 - 9 AT ANCHOR TERMINAL
 - 10 TP TEST POINT

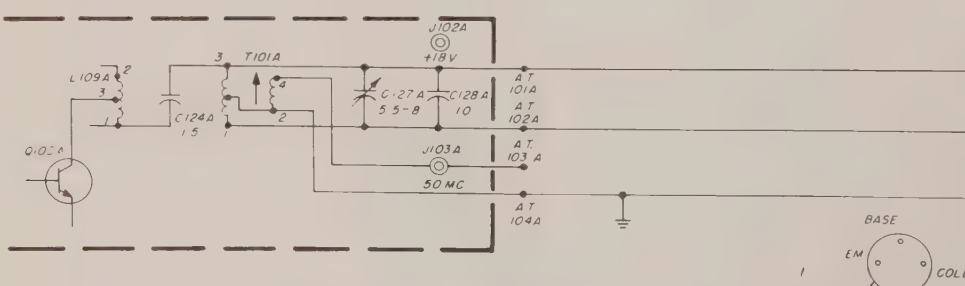
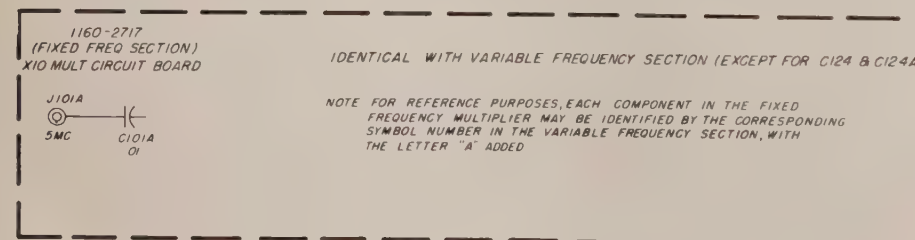
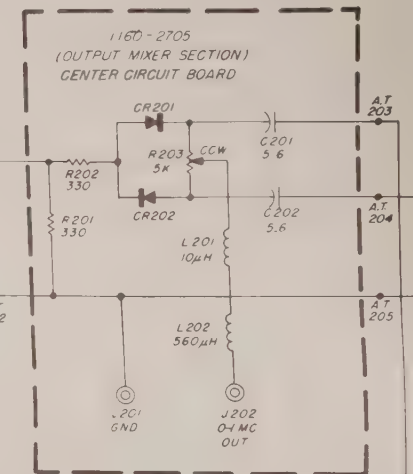
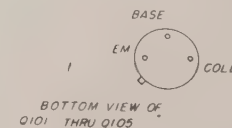


Figure FB-6. Over-all schematic diagram for Output Mixer OMM-1.



SERVICE INSTRUCTIONS

section **FC**

OUTPUT MULTIPLIER MIXER_OMM-2

P/N 1163-4010

(Used only in Type 1163 Synthesizers)

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GENERAL RADIO COMPANY

Concord, Massachusetts 01742

SECTION FC-1

INTRODUCTION

FC-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section has been prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension, by experienced service personnel, of the principles of operation. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate parts identification, reference designators used in the text and on the photographs are the same as those that appear on the complete schematic diagram and in the parts list.

The service instructions are written to facilitate use of a properly functioning synthesizer as a basic test frame for the module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the widespread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

Familiarity with the system principles of operation, as discussed in Section 4 of the front portion of this manual, is assumed as a basis for this section. Reference to other module sections should also be made as required.

FC-1.2 PURPOSE.

As noted in paragraph 4.7, the 30-c to 12-Mc output frequency of a Type 1163 Synthesizer is the result of a heterodyne between a frequency synthesized between 50 to 51 Mc/s and a frequency between 50 and 39 Mc/s.

The purpose of the OMM-2 unit is to accept from the DI train a frequency adjustable between 5.0 and 5.1 Mc/s, multiply it by 10 (to 50 to 51 Mc/s), subtract



from it the 39 to 50 Mc/s (1-Mc steps) from the DI-4, amplify the result, and feed it to the Output Amplifier (P/N 1163-4040) through the sandwich-deck wiring. Refer to Section BB (on the Main Frame) for interconnecting circuits.

FC-1.3 DESCRIPTION (Figure FC-1).

The Output Mixer module OMM-2 plugs onto the rear of the sandwich deck of the Main Frame. Ground connection between the deck and the module case is made by a series of sheet-metal springs, fastened to the deck, that grip the bottom edges of the brass-strip rails which form the outside shell of the module. Two 4-40 screws, which mate with threaded inserts at each end of the rear surface, secure the unit in place.

Circular posts mounted on the exterior surfaces of the end plates of the unit serve during disassembly as pry points, by means of which the module can be raised vertically, until the grounding springs and banana plugs are disengaged.

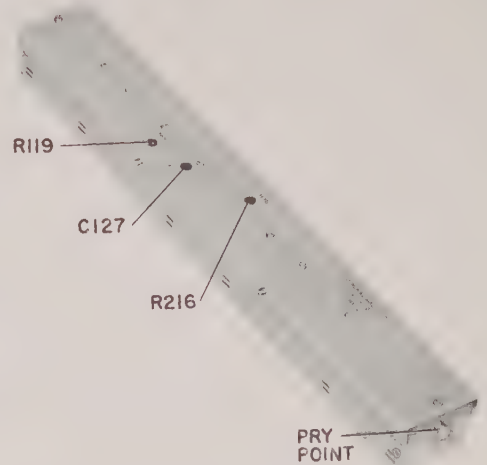


Figure FC-1. Output Multiplier Mixer module OMM-2, showing location of secondary controls.

SECTION FC-2

PRINCIPLES OF OPERATION

FC-2.1 SIGNAL FLOW.

The OMM-2 unit contains two etched-circuit boards. One is the X10 multiplier, which accepts the 5 to 5.1-Mc adjustable frequency from the DI units. The other contains an amplitude leveler for the multiplied 50 to 51-Mc signal, the input and isolation amplifier for the signal from the DI-4 (from 39 to 50 Mc/s), the output mixer, low-pass filter, and output preamplifier. A block diagram of the unit appears in Figure FC-2. The complete electrical circuit is shown in Figure FC-6.

An adjustable signal, in the band from 5 to 5.1 Mc/s, enters at J101. It drives Q101, a buffer broadly tuned at 5.05 Mc/s by L101 and C106, which drives a X5 multiplier, Q102. There are three circuits tuned to 25.0/25.5 Mc/s (the coupled pair, L102/L103, and single-tuned L104, at the collector of Q103). Q104 is a doubler, with a double-tuned 50/51-Mc circuit (L106

and L107) that couples it to the double-tuned output amplifier, Q105.

In the output circuit of Q105, T101 is very lightly loaded on its one-turn secondary. Consequently it needs very small coupling of L109 for proper band-pass characteristics. Since there is some magnetic coupling between the coils, C124 is in a bucking connection to reduce the total coupling.

The 50 to 51-Mc leveler circuit includes the components associated with Q203 and CR203. CR203 rectifies the signal produced at the output of the X10 multiplier circuit, producing a bias at Q203 that is dependent on the level of the 50 to 51-Mc signal. Q203, a dc amplifier, uses the voltage produced by the ALC detector to control the bias of Q105 and thereby control the output signal (at 50-51 Mc/s) fed to R216. R216, in turn, is a potentiometer control that can be adjusted to give the desired drive to the output mixer.

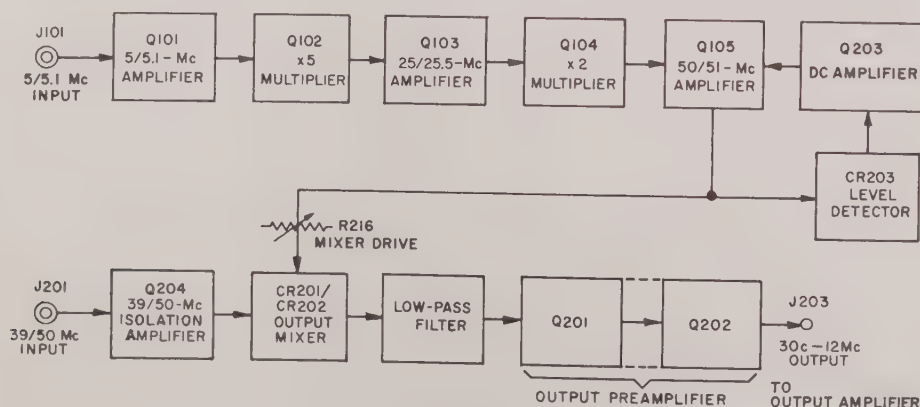


Figure FC-2. Block diagram of Output Multiplier-Mixer OMM-2.



The output mixer, comprising T201 and CR201/CR202, is driven by Q204 and the 50 to 51-Mc signal described above. Q204 is an isolation amplifier driven by the DI-4 signal (39-50 Mc/s) that prevents signals in the mixer from being fed back to the DI-4. The signal levels fed to the mixer differ in voltage level by about 10:1, the 39 to 50 Mc/s from Q204 being the higher signal. The output level from the mixer is thus controlled by the leveled 50 to 51-Mc input from T202.

The mixer load comprises R201 and the low-pass filter. The low-pass filter is an elliptic-function filter designed to have 0.1-dB ripple in the 0 to 12-Mc pass-band of the Type 1163 Synthesizer and fast roll-off to reject the 39 to 51-Mc signals also coming from the mixer. The filter has a minimum rejection of 65 dB, beyond 30 Mc/s. The elements in the filter are either fixed precision, or factory preadjusted, and cannot be adjusted in the field.

The signal at the filter, which is about 10 mV, drives the two-stage, wide-band preamplifier Q201 and Q202. Q201 is a common-emitter, emitter-compensated stage loaded by a common-emitter, shunt-feedback stage, Q202. The load resistor for Q202 is R401, the 250-ohm OUTPUT LEVEL control on the front panel of the Main Frame (refer to Section BB).

The high-frequency compensation for Q201 comprises R206 and C208. The high-frequency compensation for Q202 consists of R208 and L203. The low frequency cutoff is determined by C207, C210, and the associated impedances, but C209 and R208 increase the gain of Q202 at low audio frequencies. The actual shape of the response curve depends on the tolerances of these components, but a typical unit is nearly flat to 10 c/s. The low-frequency output response (of the Type 1163) is therefore largely determined by the Output Amplifier, P/N 1163-4040 (Section BB).

FC-2.2 INPUT AND OUTPUT CONNECTIONS.

Input and output connections to the OMM-2 unit are made through seven banana jacks and one ground lug.

The 5/5.1-Mc input from the DI units comes into J101. The 39/50-Mc signal from the DI-4 arrives at J201, where a ground pin and spring (on the chassis) are used to keep signal paths short.

The +18 V dc arrives at two jacks, one for the multiplier, J102, and one for the preamplifier circuits, J202.

The output is carried to the front-panel OUTPUT LEVEL control via J203 and associated ground return, J204; refer to Section BB for details on this wiring. The impedance of OUTPUT LEVEL control R401 is sufficiently low so the cable capacitance can be ignored.

J103 connects with a banana plug in the sandwich deck, which is wired through an isolating resistor to subminiature jack J154 at the rear edge of the deck, to make available 50/51 Mc/s, at a low power level.

FC-2.3 CONTROLS.

There is provision for access through the top cover of the module for three secondary controls, C127, R216 and R119. These controls should rarely need adjustment.

C127 is a screwdriver-adjustable trimmer capacitor placed in the output tank circuit of the multiplier strip. It is useful for touch-up adjustments of the multiplier output to the mixer circuit.

The setting of R216 determines the drive to the preamplifier and the over-all synthesizer output. It should be set so that the synthesizer will deliver full rated output (2.0 V open circuit) at all frequencies.

R119 is a gain control in the X10 multiplier circuit, useful only when no leveling circuit is available, i.e. when this board is installed as part of the OMM-1 unit (Section FB). In the OMM-2 module, this control is set fully clockwise.

The frequency alignment of this module is slightly sensitive to the presence of the top cover. As a result, final touch-up adjustments must be made with the cover in place and the unit mounted on the Main Frame.

SECTION FC-3

SERVICE AND MAINTENANCE

FC-3.1 GENERAL.

If the system trouble-analysis procedures of Section 5 at the front of the manual indicate possible malfunction of the OMM-2 unit, the most positive verification of this suspicion is the substitution of another OMM-2 module.

Since there is but one OMM-2 module per instrument and since service spares may not be available, it will not always be possible to make the substitution. However, selected tests, and alignment procedures can be made in the field.

FC-3.2 TEST EQUIPMENT.

Table FC-1 lists the equipment recommended for service of the module; equivalent equipment may be substituted.

FC-3.3 REMOVAL AND DISASSEMBLY.

FC-3.3.1 REMOVAL FROM MAIN FRAME.

Removal of the module is accomplished as follows:

CAUTION

Turn power off before removal of module.

a. Remove the synthesizer from its case and remove the support bar across the back of the Main Frame chassis.

b. Remove the two 4-40 Phillips-head screws that attach the module to the rear wall of the chassis.

c. Insert a small screwdriver blade through the cutout in the right-hand rear corner of the synthesizer-chassis side wall, under the circular post on the CAD end of the module.

d. Insert a second screwdriver blade between the post at the opposite end and the top of the side wall.

e. Pry both ends up simultaneously, until the ground contacts and banana plugs are disconnected.

FC-3.3.2 REMOVAL OF COVER.

Cover removal is accomplished as follows:

a. Dismount the module from the synthesizer chassis (paragraph FC-3.3.1).

TABLE FC-1
TEST EQUIPMENT RECOMMENDED

<u>Function</u>	<u>Type</u>	<u>Minimal Characteristics</u>
Electronic Voltmeter (VTVM)	GR 1806-A	2% accuracy; ac and dc capabilities; 1 to 55-Mc range; 0.2 V sensitivity; probe capacitance 2.0 pF maximum.
Oscilloscope	Tektronix Model 543 (with C/A plug-in and P6006 10x passive probe).	20 Mc/s, 0.5 V/cm, with 8 pF probe capacitance.
Standard Sweep Frequency Generator	GR 1025-A	0.5% calibration accuracy.

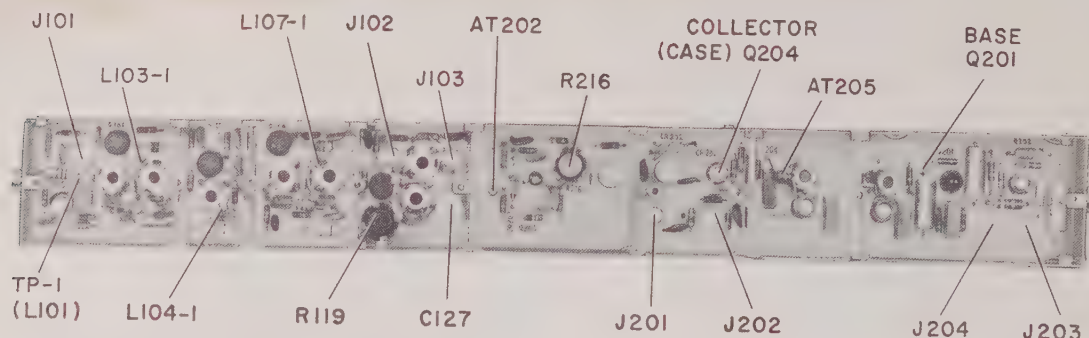


Figure FC-3. Interior view of OMM-2 module showing test points and secondary adjustment controls.

- b. Remove the nine 4-40 screws in the top of the module and the two from each side to release the cover.
- c. Lift the cover off and retain it and the screws.

FC-3.3.3 REASSEMBLY AND INSTALLATION.

Installation of the cover is the reverse of the above. When reinstalling the module on the chassis be sure that its bottom rail engages the grounding springs in such a way that the springs are not damaged. Press down until the module is seated firmly in place.

FC-3.4 TROUBLE ANALYSIS.

FC-3.4.1 GENERAL (Figures FC-3 and FC-6).

Malfunction within an OMM-2 module, as indicated by the system trouble-analysis procedures found in Section 5 at the front of the manual, can be isolated further here. The indications obtained from external connectors and test points on the synthesizer can be used to localize the difficulty to a particular circuit. In the procedures that follow, the top cover must be removed to permit access to interior test and adjustment points (refer to paragraph FC-3.3.2). See Figure FC-3 for locations of interior test points and adjustment controls.

In the performance of these tests, the synthesizer Main Frame chassis is used to support the unit, and the other modules are used to power it and to supply loads for its outputs. All DI modules or bridging units should be in place.

With the case removed from the synthesizer and the mixer unit installed (less cover), the instrument can be operated on the test bench.

FC-3.4.2 POWER-SUPPLY.

Measure power-supply input voltage at J102 and J202. This voltage should be $+18 \pm 0.2$ Vdc. If not, tests should be made elsewhere in the system to correct this defect (refer to Sections BB and GC).

FC-3.4.3 SIGNAL CHECKS.

The OMM-2 is not operating properly if the output at J203 (normally 0.8 V) is absent, low, or distorted, while both inputs at J101 (5/5.1 Mc/s) and J201 (39/50 Mc/s) are present, at an approximate level of 0.3 V, rms. Set the front-panel OUTPUT LEVEL control fully CCW for this test.

Absence or low level of output signal may be due to failure of the multiplier section, or isolation amplifier, Q204. A check of voltages is given in Table FC-2. Low voltage at J103 will lower the mixer output; low voltage at the collector of Q204 will distort the output signal.

If no indication can be obtained at either J103 or AT202, proceed sequentially with the probe down the capacitively coupled tuned circuits, from the center toward the input buffers. The test point is always terminal 1 of L109, L107, L106, L104, L103 and L102. The stage immediately following the last tank circuit at which rf can be found, is very likely defective.

If signals are present at both sides of the mixer, measure the output of the mixer at the output of the low-pass filter with a sensitive VTVM at L202 pin 2, to check operation of the mixer. Observations at test points in this end of the module should isolate trouble to a defective stage. Table FC-2 gives values for the signals at various points.

At any stage giving abnormal indications, in the course of preceding procedures, check the dc voltages of the transistors, by use of a VTVM (with probe), on the component side of the etched-circuit board, while

TABLE FC-2
TROUBLE-ANALYSIS (Figure FC-3)

Step	Section	Test Point	Indication (V, rms)
1	Mixer-Preamp	J203	0.7-1.0
2		Base, Q201	.008-.010
3		Coll. (case) Q204	2.0-3.0
4		J103	0.8-1.0
5	X10 Multiplier	L107-1	4.0
6		L104-1	4.0
7		L103-1	2.3
8		TP1 (L101)	1.9

NOTES:

- Type 1806-A with ac probe used for all measurements but step 2.
- Reference levels only; subject to fairly wide variations.
- Determination of the presence or absence of signals rather than their amplitudes will permit localization of trouble.

TABLE FC-3
DC VOLTAGE LEVELS
(Figure FC-3)

<i>Transistor</i>	<i>Collector</i>	<i>Base</i>	<i>Emitter</i>
Q101	0	16.2	16.4
Q102	16.0	0	1.9
Q103	17.1	3.0	2.4
Q104	17.1	1.0	1.6
Q105	17.8	0.4-1.5*	1.3
Q201	7.9	0.85	.076
Q202	3.6	7.9	8.5
Q203	0.4-1.5*	0.5	.02
Q204	0	12.8	13.5

NOTES:

Unit operating with all inputs, installed in chassis, no cover.

Voltages measure with Type 1806-A dc + position.

These are typical readings and they are dependent on rf levels; variations of $\pm 15\%$ are to be expected.

*Dependent on gain in ALC circuit.

the unit is installed in the chassis. Appropriate values are given in Table FC-3.

FC-3.5 ADJUSTMENT PROCEDURES.

FC-3.5.1 GENERAL (Figure FC-3).

If the trouble-analysis procedures of paragraph FC-3.4 indicate marginal performance of a circuit function, or if repairs or replacements have been made, adjustments of circuits in the OMM-2 unit may be required.

NOTE

A complete alignment of the X10 multiplier section is not possible without a sweep-generator setup and a special cover.

If frequency-insensitive components have been replaced, no alignment will be required. Repairs in the X10 multiplier section can affect the instrument output-frequency response and the output level; repairs in the remainder of the module may affect the level and distortion of the output-frequency.

FC-3.5.2 X10 MULTIPLIER SECTION CHECKS.

To test the X10 multiplier and ALC circuit section, after replacement of frequency-insensitive components, proceed as follows:

a. Set the synthesizer to 5.000000-Mc output frequency and OUTPUT LEVEL to 2.0 V.

b. Set the MONITOR switch to OUTPUT VOLTS.

c. Rotate the dial of the X100 KC DI through all 10 positions (5.0 to 5.9 Mc/s) and observe the MONITOR meter.

d. If the output-level indication does not vary more than a fraction of a division (1 division $\approx 0.2V$), it can be assumed that the X10 multiplier and leveler circuits are operating properly.

e. If larger variations are observed, realignment at the factory is required.

FC-3.5.3 MIXER PREAMP TESTS AND ALIGNMENT.

NOTE

The following information assumes that the X10 multiplier circuit and ALC control are in proper operating condition (paragraph 3.5.2).

The only adjustment in this section is the mixer drive, R216. This control is adjusted to give 2 volts open-circuit at the synthesizer OUTPUT jack, when the OUTPUT LEVEL control is full CW. If the voltage at J203, resulting from this adjustment, is greater than 0.9 V, rms, at the synthesizer output frequency, an additional check should be made to see that no malfunction exists in the Output Amplifier (refer to Section BB).

If the output characteristic of the synthesizer is insufficiently flat, and if the voltage at AT202 is within limits over the DI adjustment range (paragraph 3.5.2), interconnections at AT204 and AT205 may be opened and a response check made of the low-pass filter and preamplifier section only. A drive signal of 9-11 mV should result in an output of 0.8 V at J203; use the sweep-frequency generator. With a constant signal level at AT205, the level at J203 should not vary more than ± 0.5 dB from 50 c/s to 12 Mc/s. The OUTPUT LEVEL control on the front panel of the synthesizer should be fully CCW for this measurement.

FC-3.6 REPAIRS AND REPLACEMENTS.

If subnormal circuits don't respond to adjustments indicated in the alignment procedures, use the schematic diagram, Figure FC-6, to localize the trouble area; replace defective detail parts. The parts list gives pertinent descriptive information on parts used and reference designators appearing there are the same as those used on schematics and photos. The composite view of the etched-circuit board presented in Figures FC-4 and FC-5 show the locations of all detail parts in the module. These figures can also be used to find top-of-board contacts with transistor leads.

Basing diagrams for the transistor types used are given on the schematic diagrams. The collector lead is identified by a dot on the foil side of the etched-circuit boards.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C101	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C102	Ceramic, 0.47 μ F $\pm$ 20% 25 V	4400-2054	80183	5C13, 0.47 μ F $\pm$ 20%	5910-974-5696
C103	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C104	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C105	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	72136	CM15, 200 pF $\pm$ 5%	
C106	Mica, 75 pF $\pm$ 5% 500 V	4700-0375	14655	22A, 75 pF $\pm$ 5%	
C107	Ceramic, 1.5 pF $\pm$ 5% 500 V	4400-0150	78488	GA, 1.5 pF $\pm$ 5%	
C108	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C109	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	72136	CM15, 200 pF $\pm$ 5%	
C110	Ceramic, 10 pF $\pm$ 5% 500 V	4400-1100	78488	GA, 10 pF $\pm$ 10%	5910-061-8236
C111	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C112	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	72136	CM15, 200 pF $\pm$ 5%	
C113	Ceramic, 16 pF $\pm$ 5% 500 V (NPO)	4410-0165	72982	801, 16 pF $\pm$ 5%	
C114	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C115	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C116	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	72136	CM15D510J	
C117	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C118	Ceramic, 0.33 pF $\pm$ 5% 500 V	4400-0033	78488	GA, 0.33 pF $\pm$ 5%	5910-253-8093
C119	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C120	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	72136	CM15D510J	
C121	Ceramic, 6.8 pF $\pm$ 10% 500 V	4400-0800	78488	GA, 6.8 pF $\pm$ 10%	
C122	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C123	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	72136	CM15D510J	
C124	Ceramic, 1.0 pF $\pm$ 5% 500 V	4400-0101	78488	GA, 1.0 pF $\pm$ 5%	5910-280-5936
C125	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	72982	831, 0.001 μ F +80-20%	5910-983-9994
C126	Ceramic, 0.01 μ F +80-20%	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C127	Trimmer, 5.5 to 18 pF 350 V	4910-2044	72982	538-002, 5.5 to 18 pF	
C128	Ceramic, 10 pF $\pm$ 5% 500 V (N30)	4411-0105	56289	40C417	
C201	Mica, 121 pF $\pm$ 1% 500 V	4710-0031	14655	22A, 121 pF $\pm$ 1%	
C202	Trimmer, 0.8 to 8.5 pF	4910-1100	73899	VC9GW, 0.8 to 8.5 pF	5910-683-7157
C203	Ceramic, 10 pF $\pm$ 5% 500 V	4411-0105	56289	40C417	
C204	Mica, 221 pF $\pm$ 1% 500 V	4710-0400	14655	22A, 221 pF $\pm$ 1%	
C205	Trimmer, 0.8 to 8.5 pF	4910-1100	73899	VC9GW, 0.8 to 8.5 pF	5910-683-7157
C206	Mica, 140 pF $\pm$ 1% 500 V	4710-0140	14655	22A, 140 pF $\pm$ 1%	
C207	Electrolytic, 180 μ F $\pm$ 20% 6 V	4450-5617	56289	150D187X0006R2	
C208	Mica, 1200 pF $\pm$ 5% 100 V	4700-0685	14655	22A, 1200 pF $\pm$ 5%	
C209	Electrolytic, 4.7 μ F $\pm$ 20% 10 V	4450-4700	56289	150D475X0015B2	5910-813-8160
C210	Electrolytic, 120 μ F $\pm$ 20% 10 V	4450-5616	56289	150D127X0010R2	
C211	Electrolytic, 47 μ F $\pm$ 20% 20 V	4450-5614	56289	150D476X0010R2	
C212	Ceramic, 10 pF $\pm$ 10% 500 V (N30)	4411-0105	56289	40C417	
C213	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C214	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C215	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	80131	CC61, 0.01 μ F +80-20%	5910-974-5697
C216	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C217	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C218	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	72982	801, 0.001 μ F $\pm$ 10%	5910-914-0087
C219	Ceramic, 150 pF $\pm$ 5% 500 V	4404-1155	72982	831, 150 pF $\pm$ 5%	
INDUCTORS					
L101	Choke, rf, 10 μ H $\pm$ 10%	4300-2200	99800	1537, 10 μ H $\pm$ 10%	
L102	Adjustable	1160-2400	24655	1160-2400	
L103	Adjustable	1160-2410	24655	1160-2410	
L104	Adjustable	1160-2400	24655	1160-2400	
L105	Adjustable, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L106	Adjustable	1160-2400	24655	1160-2400	
L107	Adjustable	1160-2410	24655	1160-2410	
L108	Adjustable, 22 μ H $\pm$ 10%	4300-2600	99800	1537, 22 μ H $\pm$ 10%	5950-668-5867
L109	Adjustable	1160-2400	24655	1160-2400	
L201	Adjustable	1163-2240	24655	1163-2240	
L202	Adjustable	1163-2231	24655	1163-2231	
L203	Adjustable, 3.9 μ H $\pm$ 10%	4300-1500	99800	1537-26, 3.9 μ H $\pm$ 10%	
RESISTORS					
R101	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225	75042	BTS, 2.2 k Ω $\pm$ 5%	5905-723-5251
R102	Composition, 18 k Ω $\pm$ 5% 1/4 W	6099-3185	75042	BTS, 18 k Ω $\pm$ 5%	5905-687-0000
R103	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335	75042	BTS, 330 Ω $\pm$ 5%	5905-686-3369
R104	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225	75042	BTS, 220 Ω $\pm$ 5%	5905-683-2240

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

FC-11

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed		Mfg Part No.	Fed Stock No.
RESISTORS (Cont)						
R105	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%		5905-723-5251
R106	Composition, 100 kΩ ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%		
R107	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%		
R108	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%		5905-686-9998
R109	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%		5905-686-9998
R110	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%		5905-681-6462
R111	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%		
R112	Composition, 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%		5905-683-2240
R113	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%		5905-681-9969
R114	Composition, 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%		5905-687-0002
R115	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%		
R116	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%		
R117	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%		5905-683-2243
R118	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%		5905-686-3129
R119	Potentiometer, composition 25 kΩ ±20%	6040-0800	01121	FWC, 25 kΩ ±20%		5905-958-7950
R120	Composition, 100 Ω ±5% 1/4 W	6090-1105	75042	BTS, 100 Ω ±5%		
R121	Composition, 330 Ω ±5% 1/4 W	6090-1335	75042	BTS, 330 Ω ±5%		5905-686-3369
R201	Composition, 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%		5905-892-0107
R202	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%		
R203	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%		
R204	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%		5905-683-2238
R205	Composition, 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%		5905-681-6462
R206	Composition, 18 Ω ±5% 1/4 W	6099-0185	75042	BTS, 18 Ω ±5%		
R207	Composition, 330 Ω ±5% 1/2 W	6100-1335	01121	RC20GF331J		5905-192-3971
R208	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%		
R210	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%		5905-681-9969
R211	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%		
R212	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%		5905-683-2238
R213	Composition, 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%		
R214	Composition, 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%		
R215	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%		
R216	Potentiometer, composition 500 Ω ±20%	6040-0300	01121	FWC, 500 Ω ±20%		5905-072-7795
R217	Composition, 560 Ω ±5% 1/4 W	6099-1565	75042	BTS, 560 Ω ±5%		
R219	Composition, 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ ±5%		5905-723-5251
R220	Composition, 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%		5905-691-0195
R221	Composition, 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%		5905-686-3369
R222	Composition, 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%		
R223	Composition, 15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 15 Ω ±5%		
R224	Composition, 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%		
R225	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%		5905-683-2243
R226	Composition, ±5% *	6099-1089	80211			5961-945-4108
TRANSISTORS						
Q101	Type 2N3250	8210-1089	80211	2N3250		5961-945-4108
Q102	Type 2N2218	8210-1028	81349	2N2218		5960-059-4464
Q103	Type 2N2218	8210-1028	81349	2N2218		5960-059-4464
Q104	Type 2N2218	8210-1028	81349	2N2218		5960-059-4464
Q105	Type 2N2218	8210-1028	81349	2N2218		5960-059-4464
Q201	Type 2N918	8210-1066	07263	2N3563		5960-059-4464
Q202	Type 2N3250	8210-1089	80211	2N3250		5960-059-4464
Q203	Type SE4002	8210-1077	24454	2N3390		5961-945-4108
Q204	Type 2N3250	8210-1089	80211	2N3250		5961-945-4108
MISCELLANEOUS						
CR201	DIODE, Semiconductor type 1N35	6082-1004	58854	1N35		
CR202	DIODE, Semiconductor type 1N35	6082-1004	58854	1N35		
CR203	DIODE, Semiconductor type 1N995	6082-1002	80368	1N995		
J101 through						
J104	JACK, Etched-circuit type	1160-6110	24655	1160-6110		
J201 through						
J204	JACK, Etched-circuit, type	1160-6110	24655	1160-6110		
T101	TRANSFORMER, Adjustable	1160-2390	24655	1160-2390		
T201	TRANSFORMER, Adjustable	5000-2603	24655	5000-2603		
T202	TRANSFORMER, Adjustable	5000-2402	24655	5000-2402		

*Value Selected by LAB 22 kΩ to 100 kΩ

SERVICE INSTRUCTIONS

section **GC**

POWER SUPPLY MODULE _PS-3

P/N 1160-4056

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**THE
GENERAL RADIO COMPANY**

West Concord, Massachusetts

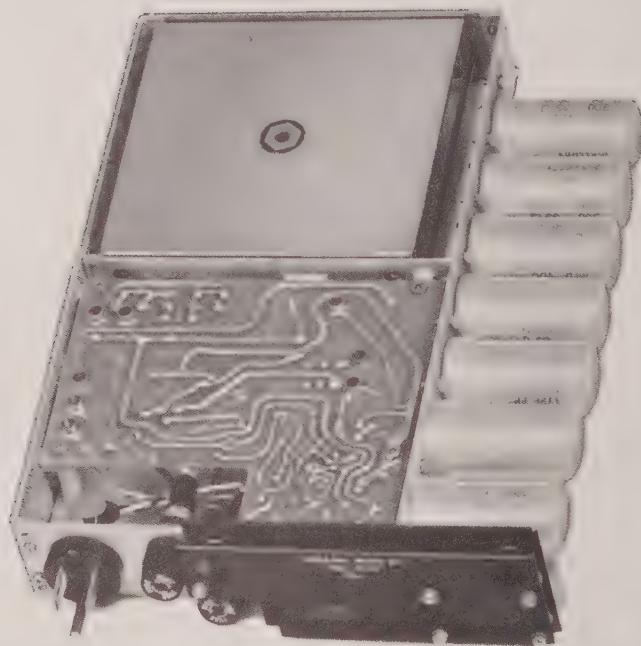


Figure GC-1.
PS-3 Power Supply module (P/N 1160-4056).

SECTION GC-1

INTRODUCTION

GC-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section is prepared with a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis."

Included in the following paragraphs are a physical description and operational discussion of the module sufficient for comprehension, by experienced service personnel, of the principles of operation. A trouble-analysis procedure that will aid in isolating the defective circuit completes the section.

To facilitate part identification, reference designators used in the text and appearing on the photograph are the same as those used on the complete schematic diagram and in the parts list. The reference designators are silk-screened on the module as a further aid in part location.

The service instructions are written to facilitate use of a properly functioning synthesizer as a basic test frame for the individual module. The instrument can be used to support the module, in a convenient bench-service position, and furnish controls and loads.

NOTE

First consideration should be given to the use of the widespread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

GC-1.2 PURPOSE.

The PS-3 Power Supply module is a compact solid-state unit that is used in synthesizer Types 1161 through 1164. As with the other modules, it is a plug-in type and can be used in all versions of these synthesizers. It is mechanically interchangeable with the PS-1 and PS-2 units.

It can be energized from ac line sources ranging from 100 to 250 volts, or from a 20-to 28-volt dc primary input. Table GC-1 lists various input-power

TABLE GC-1
PRIME-POWER-INPUT CONFIGURATIONS

<u>Line Voltage</u>	<u>Frequency (Hz)</u>	<u>Power*</u>	<u>Remarks</u>
100 - 125	50 - 400	55 W	Set switch to proper range.
200 - 250	50 - 400	55 W	
20 - 28	dc	1.8 A (with no auxiliary output load)	Refer to paragraph 2.2.2 (front portion of this manual).

*Dependent on DI complement and auxiliary output load. The value given is typical for a complete synthesizer with an external 0.2A load.



TABLE GC-2
DC POWER OUTPUTS
(Figure GC-2)

Name	Jack	Output		Use
		Volts (dc)	Amperes	
+18 V #1	J507	+18, regulated	1.350*	B+ for all modules, plus auxiliary output at rear of Main Frame (0.2 A maximum).
+18 V #2	J506	+18, regulated	0.120	B+ for Picket-Fence Section of AFS module only.
+18 V #3	J508	+18, regulated	0.180	B+ for output amplifier.
LAMPS	J505	+23 V, unregulated	0.250	Energizes lamps in all DI's and CAD module.

*Dependent on DI complement and auxiliary output load. The value given is typical for a complete synthesizer, with an external 0.2A load.

arrangements. The selected ac power-input range is indicated by the switch and is plainly visible when the supply is in the synthesizer. Line frequency of ac inputs should not exceed the range 50 to 400 Hz.

The PS-3 supplies the entire power requirements for the synthesizer, including programming circuitry (refer to Table GC-2). In addition, it can supply auxiliary power for light loads (0.2 A, maximum).

GC-1.3 DESCRIPTION

The PS-3 Power Supply module (see Figure GC-1) mounts on the under side of the Main Frame chassis deck, at the right-hand side. It engages eight banana plugs protruding from the deck and is held in place by three 10-32 screws. Two screws with special heads attach to threaded inserts in the rear edge of the deck and a third screw passes through the unit into the bottom of the deck. The plugs distribute the outputs and connect to primary input power and the front-panel POWER switch.

Rectifying and regulating circuitry consists entirely of silicon solid-state devices, for the most part mounted on an etched-circuit board.

The power supply is designed to operate over a temperature range of 0 to 50°C. An open layout permits good ventilation in all parts of the unit; heat sinks of substantial capacity complete the thermal control.

Because of the sensitivity of synthesizer circuits to magnetic fields, special precautions are taken to

reduce strong fields to a very low level. The power transformer is toroidal, and is completely shielded in a high-permeability metal case.

A screwdriver-adjustable potentiometer, accessible through the rear panel of the supply, can be used for fine adjustment of the output voltage. Internal adjustments are provided for current limiting and ripple adjustment.

The primary ac input plug is a UL-approved three-wire type mounted on the rear surface, with a third terminal wired to case ground for user safety. Two different 3AG Slo-Blo fuses in screw-type mounts are used for protection at 110 V or 220 V. They are replaceable from the rear panel.

GC-1.4 DC POWER INPUT.

The power supply can be energized from a 1.8-A source of 20 to 28 Vdc, if the input-power cord is removed and the positive side of the battery is attached to J551 on the rear panel. The negative side must be connected to the case. The synthesizer POWER switch is inoperative in this mode.

The external supply should be of low impedance such as a storage battery, otherwise the regulator circuits may not start when power is applied to J551.

In this case, the external supply is left connected to J551 and a momentary connection from J552 to ground is used to start the regulator.

SECTION GC-2

PRINCIPLES OF OPERATION

GC-2.1 GENERAL (Figure GC-4).

The PS-3 power-supply module uses a conventional series-regulator circuit to stabilize the +18 Vdc (all three B+ outputs) and to obtain low ripple. In this regulator, transistor Q501 is directly in series with the load and is used as a variable impedance.

Control of this transistor is achieved by comparison of the output voltage with a Zener-diode reference (CR506/CR508), by amplification of the difference (or error) voltage, and by application of this signal to regulating transistor Q502. The resulting loop affords tight control, which keeps the output voltage near 18 Vdc for both input-voltage changes and load-current variations. Typical performance figures are: 60-mV change for a load change from 0 - 1.7 A, and 15-mV change for an input voltage change from 115 V to 125 V. Ripple voltage (120 Hz) is below 600 μ V, as measured at J507 with a full load of 1.7 A.

GC-2.2 CIRCUIT DETAIL.

Fuses F501 and F502 protect the transformer and the rectifier diodes. R512 is a power resistor rated to handle high currents in the lamp line. Brief accidental short circuits will thus not be cause for fuse replacement. The regulator itself is short-circuit proof and current limited.

Voltage regulation and current limiting are achieved in the following manner. The available output current, and the series voltage drop across Q501, depend on the Q501 base current. The maximum available base current is controlled by Q503, according to the setting of R504. A limit is thus provided for the power-supply output current. If Q503 cuts off, due to falling power-supply output voltage under overload,

there can be no base current for Q501. Q503 thus serves as a current limiter and protects against short circuits. Voltage regulation, under normal load conditions, results from the action of Q502 in bleeding off part of the otherwise-available base current for Q501, in response to the amplified error signal from Q504. Q504 compares a fraction of the output voltage with the fixed voltage drop across Zener diodes CR506 and CR508 and controls Q502, as necessary, to maintain minimum difference.

Since Q503 cannot turn on unless there is output voltage, and there cannot be output voltage unless Q503 is turned on, the regulator obviously needs a starting circuit. This is provided by the charging current for C510. This charging current, after a shut-down, flows through Q501, CR505 and R503, and furnishes a momentary starting pulse to Q501.

The regulator will not start, when power is applied after a short circuit, unless the lamp-circuit load is connected. This load discharges the capacitor bank consisting of C503 through C507; it also discharges C510 through Q502. The time constant is of the order of a few seconds, and this interval must be allowed between the time the power switch is turned off after an accidental short and the time it is turned back on to restart the regulator.

For dc operation from a source with poor regulation, it is necessary to start the regulator by momentary connection of J552 to ground, after J551 has been connected to the dc source. Otherwise, the potential at C503 through C507 will rise too slowly to form a proper starting pulse.

R507 and C508 are a ripple-compensation network. Diode CR507, which is found in the lower arm of the voltage divider, compensates for the effects of the temperature coefficients of Q504 and reference diodes CR506 and CR508.

SECTION GC-3

SERVICE AND MAINTENANCE

GC-3.1 GENERAL.

Except for the replacement of primary line fuses, the synthesizer must be removed from its case before service can be performed on the power-supply module.

In the procedures that follow, the four outputs of the supply can be measured with the unit in place on the synthesizer if, with the power-supply cover plate removed, the instrument is operated inverted on the test bench. The correct values are given in paragraph GC-3.2.

If the voltages are present, and within tolerance (or can be adjusted within tolerance with R511), the problem must be in system interconnecting wiring on the Main Frame chassis; reference must be made to sections BA, BB, or BC, as appropriate.

If the voltage indications are abnormal, detailed trouble analysis of the supply can be performed. Figure GC-2 shows the location of test points and the secondary controls, R504 and R507.

Figure GC-3 is a composite view of the etched-circuit board found in the supply. Used in conjunction with the over-all schematic diagram, Figure GC-4, it should facilitate isolation of defective parts.

GC-3.2 MINIMUM PERFORMANCE CHECKS AND ADJUSTMENTS.

Look for +23 Vdc at J505, if lamp circuits are inoperative; see Figure GC-2.

To check regulator performance on the synthesizer chassis, determine the ripple level and measure the 18-V output. If the output at J507 is $+18 \pm 0.1$ Vdc, and the ripple is below 600 μ V, it can be assumed safely that the regulator is fully operative. To minimize the ripple, connect a sensitive ac voltmeter to the +18 V, No. 1, output (J507) and adjust R507. J507 is the lowest impedance output and therefore least apt to have other disturbing signals on it.

If it is desired to check current limiting, connect a variable load (a 100- Ω , 20-W rheostat set to maximum),

in series with a 0-2-A meter, to the auxiliary +18-V output on the Main Frame chassis (J153) or the +18V, No. 1, terminal (J507). If necessary, adjust R504 so that, as the load resistance is reduced, the current never exceeds 1.0 A before the regulator shuts down (short circuit).

NOTE

Do not leave the load set to draw current in excess of 0.2A for longer than a few seconds. R507 will have to be reset for a minimum ripple with normal load, if the R504 setting has been altered or if the load has been altered substantially by removal or installation of DI units.

Voltages under load at outputs No. 2 (J506) and 3 (J508) should be 17.95 ± 0.1 V and 17.60 ± 0.1 V, respectively. All voltages are adjusted by R511, which is accessible from the rear of the supply.

TABLE GC-3
DC VOLTAGES

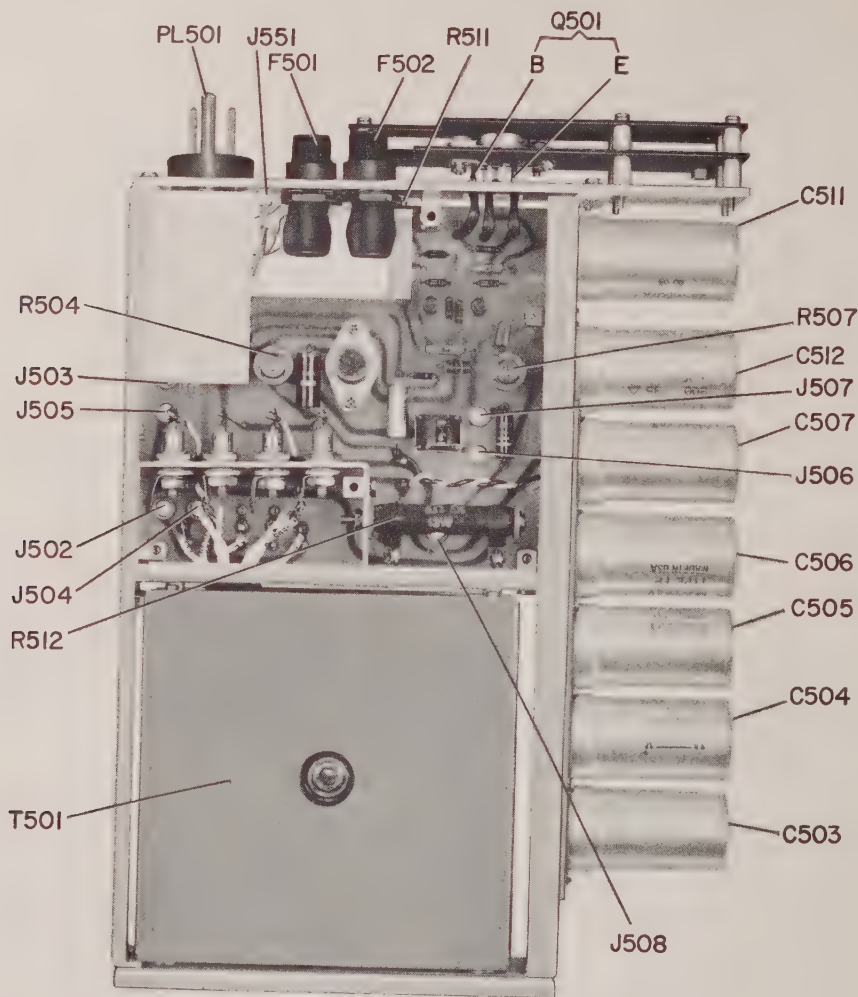
(Figure GC-2)

Stage	Collector	Base	Emitter
Q501	18.0	22.5	23.2
Q502	21.9	22.5	23.2
Q503	21.9	(8.7)*	(8.1)*
Q504	22.5	11.6	11.0

NOTES:

Unit operating in chassis (powering Synthesizer).
Voltages measured with GR Type 1806 (dc+ position).
These are typical readings partly dependent on Zener-diode voltage tolerances; variations of $\pm 10\%$ are to be expected.

*Q503 emitter and base readings dependent on beta of Q501 and Q502.



NOTE: Suffixes used:

B = Base
E = Emitter

Figure GC-2. Interior test points and secondary controls for PS-3 module (shown with cover plate removed).

GC-3.3 TROUBLE ANALYSIS.

Consult Table GC-3 for a listing of transistor voltages to perform a detailed trouble analysis, if unable to obtain the voltages indicated in paragraph GC-3.2.

Repair or replace defective parts. The parts list which follows gives the values of all electrical parts.

GC-3.4 FUSE CHANGES.

The fuses can be removed from the module without having to remove the unit from the synthesizer. Primary line fuses, F501 and F502, are standard 3AG units that mount in screw-type extractor-post holders on the rear apron of the module. The two fuses are different. Note markings on fuses and holders.

GC-3.5 REMOVAL.

The PS-3 module can be removed from the synthesizer chassis as follows:

- a. Turn off synthesizer power.
- b. Remove the synthesizer from its case and invert the instrument on the bench.
- c. Remove the screw that passes through the center of transformer T501, on the bottom surface of the module.
- d. Release the two screws that fasten the supply to the rear apron of the synthesizer.
- e. Lift the unit straight up, away from the deck, until the banana plugs are disengaged.

Installation is the reverse of removal.

GC-3.6 INPUT-VOLTAGE SELECTION.

A slide switch sets the supply to either 100 - 125 V or 200 - 250 V operation.

FEDERAL MANUFACTURERS CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1
(Name to Code) and H4-2 (Code to Name) as supplemented through June, 1967.

Code	Manufacturers Name and Address	Code	Manufacturers Name and Address	Code	Manufacturers Name and Address
00192	Jones Mfg. Co., Chicago, Illinois	53021	Sangamo Electric Co., Springfield, Ill. 62705	83033	Meissner Mfg., Div. of Maguire Industries, Inc. Mount Carmel, Illinois
00194	Walsco Electronics Corp., Los Angeles, Calif.	54294	Shallcross Mfg. Co., Selma, N. C.	80431	Air Filter Corp., Milwaukee, Wisc. 53218
00656	Aerovox Corp., New Bedford, Mass.	54715	Shure Brothers, Inc., Evanston, Ill.	80583	Hammarlund Co. Inc., New York, N. Y.
01009	Alden Products Co., Brockton, Mass.	56289	Sprague Electric Co., N. Adams, Mass.	80740	Beckman Instruments, Inc., Fullerton, Calif.
01121	Allen-Bradley, Co., Milwaukee, Wisc.	59730	Thomas and Betts Co., Elizabeth, N. J. 07207	81073	Grayhill Inc., LaGrange, Ill. 60525
01295	Texas Instruments, Inc., Dallas, Texas	59875	TRW Inc. (Accessories Div), Cleveland, Ohio	81143	Isolantite Mfg. Corp., Stirling, N. J. 07980
02114	Ferroxcube Corp. of America, Saugerties, N. Y. 12477	60399	Torrington Mfg. Co., Torrington, Conn.	81349	Military Specifications
02606	Fenwal Lab. Inc., Morton Grove, Ill.	61637	Union Carbide Corp., New York, N. Y. 10017	81350	Joint Army-Navy Specifications
02660	Amphenol Electronics Corp., Broadview, Ill.	61864	United-Carr Fastener Corp., Boston, Mass.	81751	Columbus Electronics Corp., Yonkers, N. Y.
02768	Fastex Division of Ill. Tool Works, Des Plaines, Ill. 60016	63060	Victoreen Instrument Co., Inc., Cleveland, Ohio	81831	Filton Co., Flushing, L. I., N. Y.
03508	G. E. Semiconductor Products Dept., Syracuse, N. Y. 13201	63743	Ward Leonard Electric Co., Mt. Vernon, N. Y.	81860	Barry Controls Div. of Barry Wright Corp., Watertown, Mass.
03636	Grayburne, Yonkers, N. Y. 10701	65083	Westinghouse (Lamp Div), Bloomfield, N. J.	82219	Sylvania Electric Products, Inc., (Electronic Tube Div.), Emporium, Penn.
03888	Pyrofilm Resistor Co., Cedar Knolls, N. J.	65092	Weston Instruments, Weston-Newark, Newark, N. J.	82273	Indiana Pattern and Model Works, LaPort, Ind.
03911	Clairex Corp., New York, N. Y. 10001	70485	Atlantic-India Rubber Works, Inc., Chicago, Ill. 60607	82389	Switchcraft Inc., Chicago, Ill. 60630
04009	Arrow, Hart and Hegeman Electric Co., Hartford, Conn. 06106	70563	Amperite Co., Union City, N. J. 07087	82647	Metals and Controls Inc., Attleboro, Mass.
04713	Motorola Semi-Conduct Product, Phoenix, Ariz. 85008	70903	Belden Mfg. Co., Chicago, Ill. 60644	82807	Milwaukee Resistor Co., Milwaukee, Wisc.
05170	Engineered Electronics Co., Inc., Santa Ana, Calif. 92702	71126	Bronson, Homer D., Co., Beacon Falls, Conn.	83058	Carr Fastener Co., Cambridge, Mass.
05624	Barber-Colman Co., Rockford, Ill. 61101	71294	Canfield, H. O. Co., Clifton Forge, Va. 24422	83186	Victory Engineering Corp. (IVECO), Springfield, N. J. 07081
05820	Wakefield Eng., Inc., Wakefield, Mass. 01880	71400	Bussman Mfg. Div. of McGraw Edison Co., St. Louis, Mo.	83361	Bearing Specialty Co., San Francisco, Calif.
07127	Eagle Signal Div. of E. W. Bliss Co., Baraboo, Wisc.	71590	Centralab, Inc., Milwaukee, Wisc. 53212	83587	Solar Electric Corp., Warren, Penn.
07261	Avnet Corp., Culver City, Calif. 90230	71666	Continental Carbon Co., Inc., New York, N. Y.	83740	Union Carbide Corp., New York, N. Y. 10017
07263	Fairchild Camera and Instrument Corp., Mountain View, Calif.	71707	Coto Coil Co. Inc., Providence, R. I.	84411	TRW Capacitor Div., Ogallala, Nebr.
07387	Birtcher Corp., No. Los Angeles, Calif.	71744	Chicago Miniature Lamp Works, Chicago, Ill.	84835	Lehigh Metal Products Corp., Cambridge, Mass. 02140
07595	American Semiconductor Corp., Arlington Heights, Ill. 60004	71785	Cinch Mfg. Co. and Howard B. Jones Div., Chicago, Ill. 60624	84971	TA Mfg. Corp., Los Angeles, Calif.
07828	Bodine Corp., Bridgeport, Conn. 06605	71823	Darnell Corp., Ltd., Downey, Calif. 90241	86577	Precision Metal Products of Malden Inc., Stoneham, Mass. 02180
07829	Bodine Electric Co., Chicago, Ill. 60618	72136	Electro Motive Mfg. Co., Willmington, Conn.	86684	RCA (Electrical Component and Devices) Harrison, N. J.
07910	Continental Device Corp., Hawthorne, Calif.	72259	Nytronics Inc., Berkeley Heights, N. J. 07922	86800	Continental Electronics Corp., Brooklyn, N.Y. 11222
07983	State Labs Inc., N. Y., N. Y. 10003	72619	Dialight Co., Brooklyn, N. Y. 11237	88140	Outler-Hammer Inc., Lincoln, Ill.
07999	Amphenol Corp., Borg Inst. Div., Delavan, Wisc. 53115	72699	General Instrument Corp., Capacitor Div., Newark, N. J. 07104	88219	Gould Nat. Batteries Inc., Trenton, N. J.
08790	Vemaline Prod. Co., Franklin Lakes, N. J.	72765	Drake Mfg. Co., Chicago, Ill. 60656	88419	Cornell Dubilier Electric Corp., Fuquay-Varina, N. C.
09213	General Electric Semiconductor, Buffalo, N. Y.	72825	Hugh H. Eby, Inc., Philadelphia, Penn. 19144	88627	K and G Mfg. Co., New York, N. Y.
09408	Star-Tronics Inc., Georgetown, Mass. 01830	72962	Elastic Stop Nut Corp., Union, N. J. 07083	89482	Holtzer Cabot Corp., Boston, Mass.
09823	Burgess Battery Co., Freeport, Ill.	72982	Erie Technological Products Inc., Erie, Penn.	89665	United Transformer Co., Chicago, Ill.
09922	Burdry Corp., Norwalk, Conn. 06852	73138	Beckman, Inc., Fullerton, Calif. 92634	90201	Mallory Capacitor Co., Indianapolis, Ind.
11236	C.P.S. of Berne, Inc., Berne, Ind. 46711	73359	Amper Electronics Co., Hicksville, N. Y.	90750	Westinghouse Electric Corp., Boston, Mass.
11599	Chandler Evans Corp., W. Hartford, Conn.	735915	Carling Electric Co., W. Hartford, Conn.	90952	Hardware Products Co., Reading, Penn. 19602
12498	Teledyn Inc., Crystalsides Div., Cambridge, Mass. 02140	73690	Elco Resistor Co., New York, N. Y.	91032	Continental Wire Corp., York, Penn. 17405
12672	RCA Commercial Receiving Tube and Semi- conductor Div., Woodridge, N.J.	73899	J. F. D. Electronics Corp., Brooklyn, N. Y.	91146	ITT Cannon Electric Inc., Salem, Mass.
12697	Clarostat Mfg. Co. Inc., Dover, N. H. 03820	74193	Heinemann Electric Co., Trenton, N. J.	91293	Johanson Mfg. Co., Bonton, N. J. 07005
12954	Dickson Electronics Corp., Scottsdale, Ariz.	74861	Industrial Condenser Corp., Chicago, Ill.	91298	Chandler Co., Wethersfield, Conn. 06109
13327	Soliton Devices, Tappan, N. Y. 10983	74970	E. F. Johnson Co., Waseca, Minn. 56093	91637	Dale Electronics Inc., Columbus, Nebr.
14433	ITT Semiconductors, W. Palm Beach, Florida	75042	IRC Inc., Philadelphia, Penn. 19108	91662	Elco Corp., Willow Grove, Penn.
14655	Cornell Dubilier Electric Co., Newark N. J.	75382	Kulka Electric Corp., Mt. Vernon, N. Y.	91719	General Instruments, Inc., Dallas, Texas
14674	Coming Glass Works, Corning, N. Y.	75491	Lafayette Industrial Electronics, Jamaica, N.Y.	91929	Honeywell Inc., Freeport, Ill.
14936	General Instrument Corp., Hicksville, N. Y.	75608	Linden and Co., Providence, R. I.	92519	Electra Insulation Corp., Woodside, Long Island, N. Y.
15238	ITT, Semiconductor Div. of Int. T. and T., Lawrence, Mass.	75915	Littelfuse, Inc., Des Plaines, Ill. 60016	92678	Edgerton, Germeshausen and Grier, Boston, Mass.
15605	Cutler-Hammer Inc., Milwaukee, Wisc. 53233	76005	Lord Mfg. Co., Erie, Penn. 16512	93332	Sylvania Electric Products, Inc., Woburn, Mass.
16037	Spruce Pine Mica Co., Spruce Pine, N. C.	76149	Malloy Electric Corp., Detroit, Mich. 48204	93916	Cramer Products Co., New York, N. Y. 10013
19644	LRC Electronics, Horseheads, New York	76487	James Millen Mfg. Co., Malden, Mass. 02148	94144	Raytheon Co. Components Div., Quincy, Mass.
19701	Electra Mfg. Co., Independence, Kansas 67301	76545	Mueller Electric Co., Cleveland, Ohio 44114	94154	Tung Sol Electric Inc., Newark, N. J.
21335	Fafnir Bearing Co., New Britain, Conn.	76684	National Tube Co., Pittsburg, Penn.	95076	Garde Mfg. Co., Cumberland, R. I.
24446	G. E. Schenectady, N. Y. 12305	76854	Oak Mfg. Co., Crystal Lake, Ill.	95146	Alco Electronics Mfg. Co., Lawrence, Mass.
24454	G. E., Electronic Comp., Syracuse, N. Y.	77147	Patton MacGuyre Co., Providence, R. I.	95238	Continental Connector Corp., Woodside, N. Y.
24455	G. E. (Lamp Div), Nela Park, Cleveland, Ohio	77166	Pass-Seymour, Syracuse, N. Y.	95275	Vitramon, Inc., Bridgeport, Conn.
24655	General Radio Co., W. Concord, Mass 01781	77263	Pierce Roberts Rubber Co., Trenton, N. J.	95354	Methode Mfg. Co., Chicago, Ill.
26806	American Zettler Inc., Costa Mesa, Calif.	77339	Positive Lockwasher Co., Newark, N. J.	95412	General Electric Co., Schenectady, N. Y.
28520	Hayman Mfg. Co., Kenilworth, N. J.	77542	Ray-O-Vac Co., Madison, Wisc.	95794	Ansonda American Brass Co., Torrington, Conn.
28959	Hoffman Electronics Corp., El Monte, Calif.	77630	TRW, Electronic Component Div., Camden, N. J. 08103	96095	Hi-Q Div. of Aerovox Corp., Orlean, N. Y.
30874	International Business Machines, Armonk, N.Y.	77638	General Instruments Corp., Brooklyn, N. Y.	96214	Texas Instruments Inc., Dallas, Texas 75209
32001	Jensen Mfg. Co., Chicago, Ill. 60638	78189	Shakeproof Div. of Ill. Tool Works, Elgin, Ill. 60120	96256	Thordarson-Meissner Div. of McGuire, Mt. Carmel, Ill.
35929	Constanta Co. of Canada Limited, Montreal 19, Quebec	78277	Sigma Instruments Inc., S. Braintree, Mass.	96341	Microwave Associates Inc., Burlington, Mass.
37942	P. R. Mallory and Co. Inc., Indianapolis, Ind.	78488	Stackpole Carbon Co., St. Marys, Penn.	96791	Amphenol Corp. Jonesville, Wisc. 53545
38443	Marlin-Rockwell Corp., Jamestown, N. Y.	78553	Tinnerman Products, Inc., Cleveland, Ohio	96906	Military Standards
40931	Honeywell Inc., Minneapolis, Minn. 55408	79089	RCA, Commercial Receiving Tube and Semi- conductor Div., Harrison, N. J.	97666	CBS Electronics Div. of Columbia Broadcast- ing Systems, Danvers, Mass.
42190	Muter Co., Chicago, Ill. 60638	79725	Wiremold Co., Hartford, Conn. 06110	98291	Sealectro Corp., Mamaroneck, N. Y. 10544
42498	National Co. Inc., Melrose, Mass. 02176	79963	Zierick Mfg. Co., New Rochelle, N. Y.	98821	North Hills Electronics Inc., Glen Cove, N. Y.
43991	Norma-Hoffman Bearings Corp., Stanford, Conn. 06904	80030	Prestole Fastener Div. Bishop and Babcock Corp., Toledo, Ohio	99180	Transitron Electronics Corp., Melrose, Mass.
49671	RCA, New York, N. Y.	80048	Vickers Inc. Electric Prod. Div., St. Louis, Mo.	99378	Atlee Corp., Winchester, Mass. 01890
49956	Raytheon Mfg. Co., Waltham, Mass. 02154	80131	Electronic Industries Assoc., Washington, D.C.	99800	Delevan Electronics Corp., E. Aurora, N. Y.
		80183	Sprague Products Co., N. Adams, Mass.		
		80211	Motorola Inc., Franklin Park, Ill. 60131		
		80258	Standard Oil Co., Lafayette, Ind.		
		80294	Bourns Inc., Riverside, Calif. 92506		

PARTS LIST

Ref. No.	Description	Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.	
CAPACITORS						
C501	Ceramic, .01 μ F +80-20% 500 V	4406-3109	72982	811, 0.01 μ F +80-20%	5910-977-7579	
C502	Ceramic, .0068 μ F +80-20% 500 V	4406-2689	72982	811, 0.0068 μ F +80-20%		
C503A C503B	Electrolytic, 600 μ F +100-10% 35 V	4450-2400	37942	2021149S4C10X1		
C504A C504B	Electrolytic, 600 μ F +100-10% 35 V	4450-2400	37942	2021149S4C10X1	5910-822-2691	
C505A C505B	Electrolytic, 600 μ F +100-10% 35 V	4450-2400	37942	2021149S4C10X1	5910-822-2691	
C506A C506B	Electrolytic, 600 μ F +100-10% 35 V	4450-2400	37942	2021149S4C10X1	5910-822-2691	
C507A C507B	Electrolytic, 600 μ F +100-10% 35 V	4450-2400	37942	2021149S4C10X1	5910-822-2691	
C508	Ceramic, 1 μ F 20% 25 V	4400-2070	80183	5C13, 1 μ F $\pm$ 20%	5910-083-644	
C509	Ceramic, .22 μ F 20% 25 V	4400-2052	80183	5C13, 0.22 μ F $\pm$ 20%	5910-974-5694	
C510	Electrolytic, 22 μ F 20% 35 V	4450-5612	80183	150D226X0035R2		
C511A C511B	Electrolytic, 600 μ F +100-10% 35 V	4450-2400	37942	2021149S4C10X1	5910-822-2691	
C512A C512B	Electrolytic, 600 μ F +100-10% 35 V	4450-2400	37942	2021149S4C10X1	5910-822-2691	
DIODES						
CR501	Type 1N1613	6081-1012	24446	1N1613	5960-764-3184	
CR502	Type 1N1613	6081-1012	24446	1N1613		
CR503	Type 1N1613	6081-1012	24446	1N1613		
CR504	Type 1N1613	6081-1012	24446	1N1613	5960-764-3184	
CR505	Type 1N645	6082-1016	24446	1N645	5960-764-3184	
CR506	Type 1N752	6083-1004	07910	1N752	5961-944-8222	
CR507	Type 1N645	6082-1016	24446	1N645		
CR508	Type 1N752	6083-1004	07910	1N752	5961-944-8222	
CR509	Type 1N4140	6081-1014	13327	1N4140		
ETCHED CIRCUIT						
Power Supply Circuit Asm.		1160-2782	24655	1160-2782		
FUSES						
F501	Fuse, 0.8 Amp	5330-1200	71400	MDL, 0.8 Amp.	5920-284-6733	
F502	Fuse, 0.4 Amp	5330-0900	71400	MDL, 0.4 Amp.		
INDUCTORS						
L501	Inductor	5000-2829	24655	5000-2829	5920-537-6654	
L502	Inductor	4300-3100	99800	2150, 47 μ H $\pm$ 10%		
L503	Inductor	4300-3100	99800	2150, 47 μ H $\pm$ 10%		
JACKS						
J501	Jack, etched-circuit type	1160-6110	24655	1160-6110	5920-284-7144	
J502	Jack, etched-circuit type	1160-6110	24655	1160-6110		
J503	Jack, etched-circuit type	1160-6110	24655	1160-6110		
J504	Jack, etched-circuit type	1160-6110	24655	1160-6110		
J505	Jack, etched-circuit type	1160-6110	24655	1160-6110		
J506	Jack, etched-circuit type	1160-6110	24655	1160-6110		
J507	Jack, etched-circuit type	1160-6110	24655	1160-6110		
J508	Jack, etched-circuit type	1160-6110	24655	1160-6110		
J551	Jack, phone, tip type	4260-0900	98291	SKT-1		
J552	Jack, phone, tip type	4260-0900	98291	SKT-1		
MTG DEVICE FUSE						
Mtg. Device Fuse		5650-0100	71400	HKP-H		5920-284-7144
PLUG						
PL501	Plug	4240-0600	24655	4240-0600	5935-816-0254	
RESISTORS						
R501	Composition, 120 Ω 5% 1/4 W	6099-1125	75042	BTS, 120 Ω $\pm$ 5%	5905-192-3971	
R502	Composition, 560 Ω 5% 1/4 W	6099-1565	75042	BTS, 560 Ω $\pm$ 5%		
R503	Composition, 1.2 k Ω 5% 1/4 W	6099-2125	75042	BTS, 1.2 k Ω $\pm$ 5%		
R504	Pot, Composition, 2.5 k Ω 20%	6040-0500	01121	FWC, 2.5 k Ω $\pm$ 20%	5905-615-7728	
R505	Composition, 330 Ω 5% 1/2 W	6100-1335	01121	RC20GF331J		
R506	Film, 562 Ω 1% 1/4 W	6350-0562	75042	CEB, 562 Ω $\pm$ 1%		
R507	Pot, Composition, 500 k Ω 20%	6040-1200	01121	FWC, 500 k Ω $\pm$ 20%	5905-910-9467	
R508	Wire wound, 2.2 Ω 2% 2 W	6760-9225	75042	BWH, 2.2 Ω $\pm$ 2%		
R509	Film, 1.21 k Ω 1% 1/4 W	6350-1121	75042	CEB, 1.21 k Ω $\pm$ 1%		
R510	Composition, 1.20 Ω 5% 2 W	6120-1125	01121	RC42GF121J	5905-577-7504	
R511	Pot, wire wound, 500 Ω 10%	6057-1509	07999	992P, 500 Ω $\pm$ 10%	5905-279-2596	
R512	Power, 22 Ω 5% 5 W	6640-0225	75042	450560		
SWITCH						
S501	Slide type	7910-0831	42190	4603		
TRANSFORMER						
T501	Transformer,	1160-2530	24655	1160-2530		
TRANSISTORS						
Q501	Type MJ2268	8210-1113	93916	MJ2268	5905-279-2596	
Q502	Type 2N3906	8210-1112	93916	2N3906		
Q503	Type 40250	8210-1095	12672	40250		
Q504	Type 2N910	8210-1037	24454	2N910		

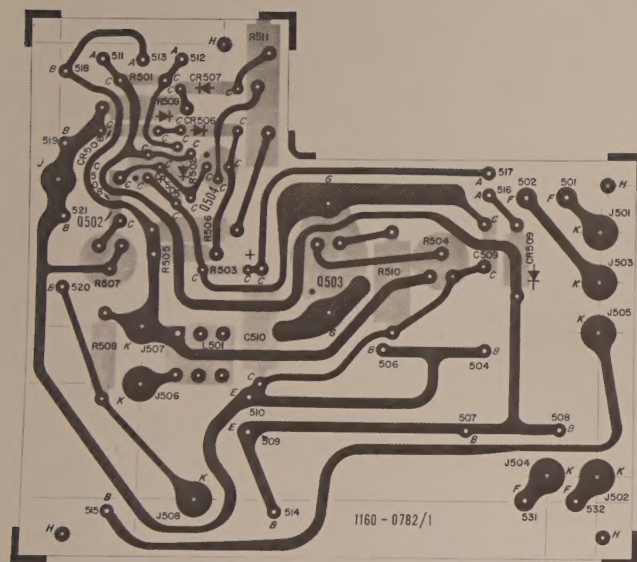


Figure GC-3. Etched-circuit board assembly (P/N 1160-2782) for PS-3 Power Supply module.

NOTE: The number appearing on the foil side is not the part number. Dot on foil indicates collector lead. Shown looking from foil side.

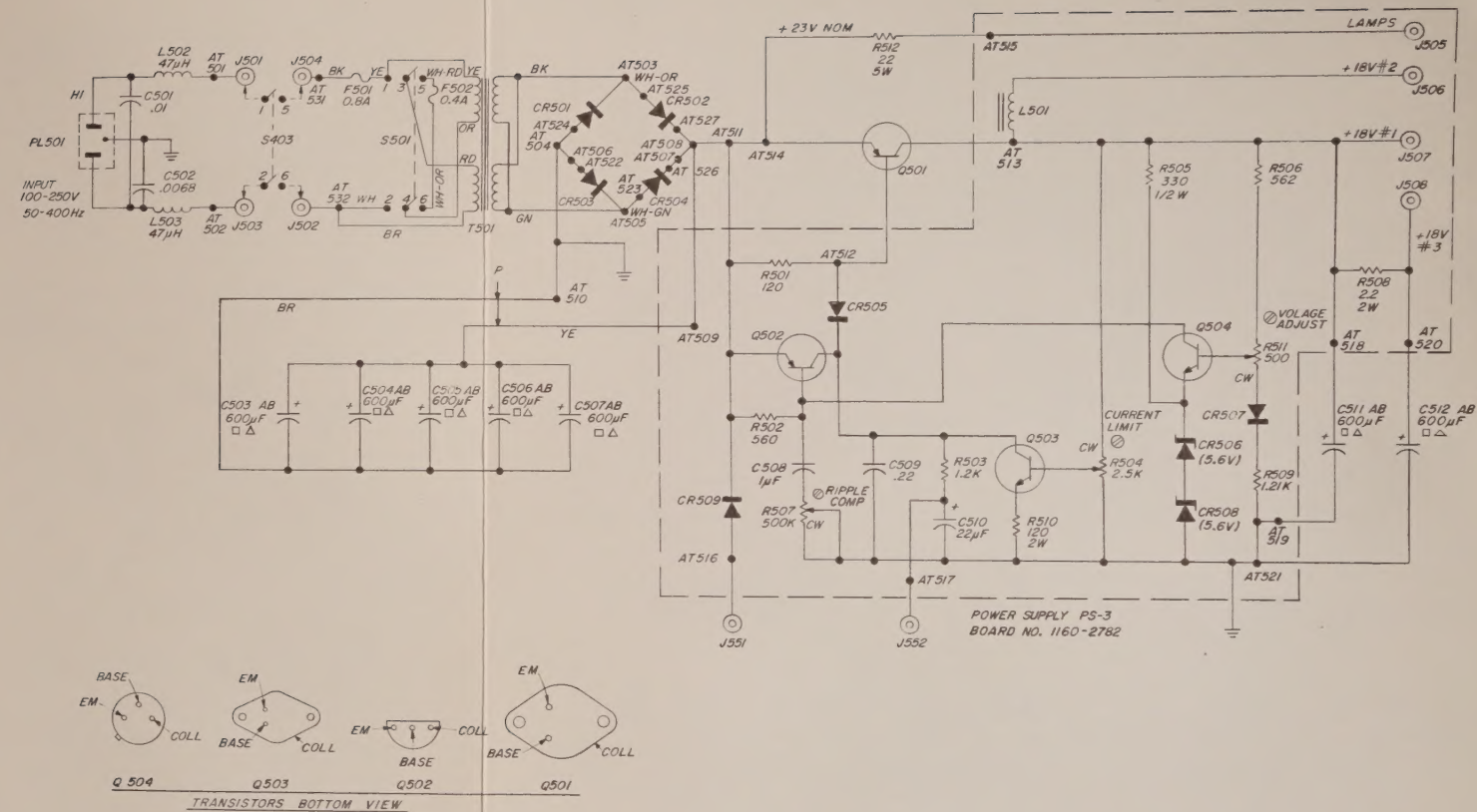


Figure GC-4. Over-all schematic diagram for PS-3 Power Supply module (P/N 1160-4056).

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